Shashwat

Volume 7 | Issue 8 | December 2021

Let Nature Be

"Restoring Green Economy"

A **GRIHA Council** Publication

COVER STORY

FACE-TO-FACE

SPECIAL FEATURE

THANKS TO OUR VALUED PARTNERS

ORGANIZED BY

GRIHA | teri The Energy and Resources Institute — *Creating Innovative Solutions for a Sustainable Future*

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MESSAGE FROM THE PRESIDENT, GRIHA COUNCIL

The COVID-19 pandemic has sent shockwaves throughout the world's society and economies. The disease's effects, as well as the means taken to combat it, have highlighted concerns about pandemic preparedness and more broadly, development in the past, present and future. If we make better economic and environmental resiliency a central part of our recovery strategy, the coronavirus pandemic can teach us a lot about how to deal with climate change.

In the midst of this chaos, it's easy to forget that only a few months ago, the argument about climate change, its socio-economic consequences, and the communal reaction it necessitated was gaining traction. Sustainability was, indeed, rising on many public- and private-sector leaders' agendas—until the unsustainable became difficult to avoid.

GRIHA Council believes that not only will climate action be critical in the coming decade, but that investments in climate-resilient infrastructure and the transition to a lower-carbon future will also result in significant near-term job creation, as well as increased economic and environmental resiliency.

In this context, the theme of this year's magazine - "Restoring Green Economy" emphasises on the importance of climate change. Climate is a fantastically complex system; the negative impact of anthropogenic activities has been exceedingly apparent in recent years with the root causes of climate change also identified as factors that increase the risk of pandemics. In 2020, global carbon-dioxide emissions plummeted in the wake of COVID-19. While the pain of economic disruption was felt around the world, the crash served as an eye-opener for climate-conscious businesses - more voices are now calling for the recovery to be based around sustainability and for the need to use the new normal, we have been forced to define to account for the climate emergency. A greener recovery can significantly enhance the resilience of economies and societies in the face of severe recession and accelerating environmental challenges.

I humbly acknowledge the unending support and trust of our valued partners and their untethered confidence in GRIHA. Without any apprehension, I can proudly say that this progress is the result of continuous soulful commitment of an exuberant team. Hence, as we move towards 2022, I know that GRIHA will continue to be a leader in building sustainability and persevere in its mission with zeal to ensure sustainability and restore a green economy.

Wishing everyone the best for the forthcoming year, 2022!

Dr Vibha Dhawan
Director General, TERI

GRIHA TIMELINE

2000-2010

2005-TERI GRIHA released as an indigenous green building rating in India

2007-MNRE adopts GRIHA as a National Rating System for Green Buildings

2008-National Mission on Sustainable Habitat launched

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

CPWD embraces GRIHA

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

❍ Evaluators' and Trainers' Programme

2011

■ CREDAI

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

2012

❍ SVAGRIHA 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 for SVAGRIHA rated projects.

2014

❍ GRIHA for Day Schools rating

GRIHA projects in MoUD, Delhi Division, Government of India

Sikkim mandates GRIHA

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 (Madhya Pradesh Police Housing) & IDC (Infrastructure Development Corporation), IICCI (Indo-Italian Chamber of Commerce and Industry)

❖ PMC announces discount in premium charges for GRIHA/ SVAGRIHA projects

Developed by

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

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2017

- ❍ GRIHA EB rating, GRIHA for AH rating
- ❍ Revamped evaluators module and exam
- ■ MPPH & IDC, PMC, BESTECH, Ireo, Vatika, CONSCIENT, ADANI Realty, Vilas Javdekar Developers and Godrej Properties
- ■ EESL (Energy Efficiency Services Limited), NHB (National Housing Bank), ISHRAE (Indian Society of Heating, Refrigerating and Air Conditioning Engineers)
- ■ 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

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

- ❍ Launch
- ■ Memorandum of understanding (MoU)
- ✸ Floor area ratio (FAR) incentive
- ❖ Green Building Incentive

2018

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

GRIHA Council felicitated with Green Excellence Award, 2018

2019

- ❍ GRIHA v 2019 (Abridged Manual)
- ❍ GRIHA for Existing Day-Schools rating

2020

- ❍ GRIHA Product Catalog Brochure
- ■ First Construction Council, IIA (Indian Institute of Architects), Northern Chapter
- ✸ GRIHA projects in Himachal Pradesh
- ❖ Govt. of Gujarat (Industries Commissionerate) offers assistance of up to 50% of consulting charges or INR 2.5 lakh, whichever is less, for industrial buildings of more than 2,000 sq.m built up area which obtain green rating from GRIHA Council,

  GRIHA, and GRIHA AH-certified (4- and 5- star projects) would be provided financial incentives under SUNREF India program

GRIHA v .2019 (User Manual)

- ❍ Release of policy brief on Sustain the Sustainable change
- ❍ 30 stories Beyond Buildings
- ✸ Extra FAR for GRIHA projects in Rajasthan
- ■ Energy Management Centre (EMC), Kerala
- ■ Confederation of Indian Micro, Small and Medium Enterprises (CIMSME), Kerala
- ■ Kerala Infrastructure Investment Fund Board (KIIFB)

2021

- ■ IIFL Housing Finance Ltd. (IIFL HFL)
- ■ Council of Architecture (renewal)
- ■ Upto 15% FAR benefits in Jammu and Kashmir for GRIHA certified projects.
- ❖ Exemption from EC for GRIHA projects in Jammu and Kashmir

Government of Maharashtra makes it mandatory to achieve a minimum of 3 star rating for construction projects under GRIHA for all buildings belonging to Government, Semi- Government, local bodies and public sector undertakings for propagating sustainable habitat development in the state.

सत्यमेव जयते

भारत के उपराष्ट्रपति
VICE-PRESIDENT OF INDIA

MESSAGE

I am happy to know that the GRIHA Council is releasing their annual magazine 'SHASHWAT – Let Nature Be' during 'The GRIHA Event' in December 2021. The theme of the publication, 'Restoring Green Economy' is extremely pertinent as we work towards restoring normalcy to our economy in a sustainable manner after this disruptive pandemic.

COVID-19 pandemic has severely impacted economies worldwide. With the largest vaccination drive underway in India, the worst seems to be over and our economy is showing promising signs of recovery.

This pandemic is a warning to the entire world that we have to strike a balance between economic growth and the environment. Development at the cost of the environment is no longer viable. Co-existence of the human species with the natural ecosystems has to be sustained prudently as we are faced with the impacts of climate change.

I am happy to note the efforts of GRIHA Council for spearheading sustainable development in the built-environment and wish the Council all success in all its future endeavours.

(M. Venkaiah Naidu)

New Delhi
7th November, 2021.

हरदीप एस पुरी
HARDEEP S PURI

सत्यमेव जयते

आज़ादी का अमृत महोत्सव

आवासन और शहरी कार्य मंत्री
पेट्रोलियम एवं प्राकृतिक गैस मंत्री
भारत सरकार
Minister of
Housing and Urban Affairs; and
Petroleum and Natural Gas
Government of India

Message

I am pleased to note that the Green Rating for Integrated Habitat Assessment (GRIHA) Council is releasing its annual magazine "Shashwat" with the theme of 'Restoring Green Economy'. As we recover from the disruptive effects of COVID-19, there is a clear imperative to rebuild our economy on sustainable foundations that are more climate-conscious. From past global experiences, it is evident that a greener recovery can significantly enhance the resilience of economies and societies in the face of environmental challenges.

The Ministry of Housing and Urban Affairs has actively promoted holistic development through the integration of various sustainable strategies in housing and other allied initiatives even as we meet the growing demands of urbanisation and the unexpected challenges posed by this pandemic. Most of the housing developed under the Pradhan Mantri Awas Yojana-Urban was done by utilising energy-efficient methods that incorporated sustainable land-use planning.

India is committed to optimising the urban footprint and energy demands through inclusive and sustainable means. In that endeavour, I appreciate GRIHA Council's mission of integrated development through diverse partnerships. I am pleased to know that the GRIHA Council is launching 'SVAGRIHA 3' – the latest version of SVAGRIHA ratings, which will certainly help in reducing negative environmental impact of small developments in our cities. I convey my best wishes to the GRIHA Council for its future endeavours.

(Hardeep S Puri)

New Delhi

22 October 2021

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आर. के. सिंह
R. K. SINGH

विद्युत मंत्री एवं
नवीन और नवीकरणीय ऊर्जा मंत्री
भारत सरकार
Minister of Power and
Minister of New & Renewable Energy
Government of India

I am delighted to learn that GRIHA Council is releasing its annual magazine "Shashwat" with the theme 'Restoring Green Economy'.

Energy is a key factor in the growth of emerging economies. Demographic Trends, Sustainable Development, Economic Growth and changes in energy prices have important implications on the world energy scenario. India is faced with its unique set of challenges and providing uninterrupted and quality power supply is a challenge that needs to be constantly worked upon.

The primary energy demand in India has grown from about 450 million tons of oil equivalent in the year 2000 to about 770 million tons of oil equivalent in the year 2012. This is expected to increase to about 1250-1500 million ton in the year 2030 (estimated in the Integrated Energy Policy Report). This increase is driven by a number of factors, the most important of which are increasing incomes and economic growth which has led to a greater demand for energy services such as lighting, cooking, space cooling, mobility, industrial production, office automation, etc.

Ministry of Power has initiated a number of energy efficiency initiatives in the areas of household lighting, commercial buildings, labeling of appliances and demand side management in agriculture, municipalities, SMEs and large industries. The Ministry has also initiated the development of energy consumption norms for industrial sub sectors, capacity building of SDAs etc. These initiatives aim at optimizing the energy growth requirement while curbing carbon emission.

I am delighted to learn that GRIHA Council is organizing "The GRIHA Event" in December 2021. I am certain the event will open doors to deliberate and rethink how moving ahead, we can uplift the economy and the environment.

I congratulate GRIHA Council on the launch the new version of the SVAGRIHA rating variant and wish them success for the GRIHA event.

(R. K. Singh)

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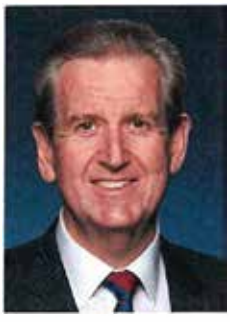
HIGH COMMISSIONER

AUSTRALIAN HIGH COMMISSION
NEW DELHI



I am delighted to learn that GRIHA Council is soon to launch the 8th edition of their annual magazine 'Shashwat – Let Nature Be'.

The theme "Restoring Green Economy" is timely as world leaders recently renewed their commitment to reduce carbon emissions at COP26. Australia is mainstreaming physical climate risk assessments across our national strategies and throughout our economy. As a member of the High Ambition Coalition for Nature and People and Global Ocean Alliance, Australia is proud to address biodiversity loss through supporting protection of 30 per cent of the world's land and 30 per cent of the world's ocean by 2030.

The theme also resonates deeply with our Indigenous Australians, who are a crucial part of these sustainable land management efforts. Through their custodianship of the land for 65,000 years, we draw on their Indigenous Ecological Knowledge to support our broader environment management.

Like India, Australia is committed to a technology-driven approach to reducing emissions. Our collective focus is on driving down the costs of new and emerging renewable energy technologies to make them affordable and more widely available. Prime Minister Modi and Prime Minister Morrison agreed to work towards a new and renewable energy technology partnership, with an initial focus on hydrogen and ultra-low cost solar. We are also working to jointly unlock the potential of Australia's critical minerals and rare earths to become inputs for Make in India renewable energy technologies, like solar modules and batteries.

I commend the GRIHA Council for their leadership and continued efforts to promote greater resource efficiency, innovation and sustainability.

The Hon Barry O'Farrell

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Enclosure(s) Case/ID No. Department Date

MESSAGE:

I am delighted to see that the GRIHA Council is soon to launch the 2021 edition of their eminent magazine "Shashwat- Let Nature Be" with the theme "Restoring Green Economy".

The theme resonates deeply with Denmark's economic policies which have been considered by many as a global frontrunner in the green transition. Investing in a green economy is important not only due to climate challenges, but also to ensure security of supply and enable the economy to become independent of unstable energy prices and scarce resources. The Danish government is now committed to increasing the share of renewables in gross final energy consumption from 30% in 2020 to 55% by 2030 and 100% in 2050. We have also achieved the decoupling of economic growth from its overall energy consumption; with the GDP increasing 100% since 1980, but the energy consumption increasing only 6%. The Danish experience over the past decades is evidence that investing in renewable energy, energy efficiency and resource optimisation makes good economic sense. In fact, Denmark has doubled its economy while reducing energy consumption and decreasing the CO2 footprint since 1980. The transition to a green economy is also at the heart of the global agenda.

In September 2020, H.E. Mette Frederiksen, Prime Minister of Denmark and Shri. Narendra Modi, Hon'ble Prime Minister of India, signed a Green Strategic Partnership to contribute to speeding up the economic recovery, accelerate green growth and create new jobs after the global COVID-19 pandemic. During the Prime Minister's state visit to India 9-11 October, Prime Minister Frederiksen and Prime Minister Modi decided to strengthen the Green Strategic Partnership further by including new areas of cooperation.

Fostering partnerships is a key requisite for attainment of a sustainable future. Just like our countries, the strategic collaboration of the Embassy with the GRIHA Council has enabled both parties to engage successfully for inclusive sustainable development and I look forward to a continuation of the same.

I convey my best wishes to the GRIHA Council for the success of the GRIHA event.

Freddy Svane
Ambassador

दुर्गा शंकर मिश्र
सचिव
Durga Shanker Mishra
Secretary

भारत सरकार
आवासन और शहरी कार्य मंत्रालय
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Government of India
Ministry of Housing and Urban Affairs
Nirman Bhawan, New Delhi-110011

MESSAGE

India is a part of the global trend towards increasing urbanization in which more than half of world's population is living in cities and towns. As per the 2011 Census about 31.16 per cent of India's population in urban areas. This puts immense stress on urban infrastructure especially in the wake of the COVID 19 pandemic.

Enhancing the productivity of urban areas is vital to the policy pronouncements of the Ministry of Housing and Urban Affairs. Cities hold tremendous potential as engines of economic social development, creating jobs generating wealth through economies of scale. They need to be sustained augmented through the high urban productivity for country's economic growth.

In this regard 'Restoring Green Economy' is a pertinent theme for GRIHA Council's annual magazine "Shashwat - Let Nature Be" that encapsulates the opinions of industry experts on a green economy is resource efficient, low carbon and socially inclusive.

The theme of this year's magazine is aligned with the Ministry's vision, attaining efficiency and equity in the delivery and financing of urban infrastructure. I take this opportunity to appreciate GRIHA Council's mission in building capacities for multi-level stakeholders towards a greener, inclusive and resilient economy.

I wholeheartedly hope that the motives and aspirations of this year's theme along with the earnest efforts all the stakeholders associated it, brings out a productive and positive outcome for our nation.

I wish GRIHA Council the very best in all future endeavors.

Durga Shanker Mishra

New Delhi
27TH October, 2021

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आलोक कुमार, भा.प्र.से.
सचिव
भारत सरकार

Alok Kumar, I.A.S.
Secretary
Government of India

सत्यमेव जयते

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MESSAGE

I am delighted to learn that GRIHA's yearly magazine, Shashwat, will focus on "Restoring Green Economy." The economic slowdown due to the pandemic served as a wake-up call for enterprises to focus on sustainable recovery, as well as account for climate change related exigencies, by adopting new policies.

With the rapid urbanization, the country's overall generation including power from grid-connected renewable sources has risen from 1110.46 BU in 2014-15 to 1381.86 BU in 2020-21.

Improving energy efficiency meets the dual objectives of promoting sustainable development and of making the economy competitive. Energy efficiency has become a very vital component of our energy policy, given the daunting challenge of meeting the energy needs of our country while providing adequate energy in a sustainable manner and at a reasonable cost. Bureau of Energy Efficiency (BEE) has initiated numerous energy efficiency initiatives in the areas of buildings, appliances, household lighting, SMEs and large industries.

To address the quantum of emissions from the "Transport" sector powered by fossil fuels, Government of India has taken several initiatives such as the National Electric Mobility Mission Plan (NEMMP) for the faster adoption of Electric Vehicles (full range of hybrid and electric vehicles) and their manufacturing and installation of Public Charging Stations throughout the country.

I would like to congratulate GRIHA Council on the launch of the latest version of their SVAGRIHA rating variant.

My best wishes to GRIHA Council.

(Alok Kumar)

RIGHT TO INFORMATION

स्वच्छ भारत
एक कदम स्वच्छता की ओर

सत्यमेव जयते

इन्दु शेखर चतुर्वेदी
INDU SHEKHAR CHATURVEDI

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

I would like to congratulate GRIHA Council on the publication of the 2021 edition of their annual magazine 'Shashwat – Let nature be'.

The threat of climate change has necessitated that we look for greener alternatives to how we presently live and work. With energy demand projected to increase sharply in the coming years, it is imperative to switch to sustainable greener alternatives for energy generation. India's efforts in this direction have seen major successes. India is now at the 5th global position in overall installed renewable energy capacity. Solar capacity has increased in the last about 7 years from around 2.6 GW to more than 42 GW.

GRIHA is contributing to these efforts by being a frontrunner in promoting renewable energy installation in the building sector. Through its rating variants, GRIHA has ensured country-wide adoption of renewable energy in new and existing buildings. I am happy to learn about the launch of the updated version of the SVAGRIHA rating variant.

I wish GRIHA Council all the success in their future endeavors.

20/10/2021

[Indu Shekhar Chaturvedi]

New Delhi
October 20, 2021

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

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आज़ादी का अमृत महोत्सव

No. AAI/CHMN/2021

December 1, 2021

MESSAGE

I heartily congratulate GRIHA Council on the launch of the 8th edition of their annual magazine SHASHWAT, which is being published this year with the theme "Restoring a Green Economy".

The theme aligns with GRIHA Council's commitments towards a transition that ensures economic growth and investment while preserving environmental quality and social inclusivity. The emphasis of GRIHA is to harness technology that helps us build better.

AAI has been continuously working to upgrade airports in India. For the last few years, AAI has been actively engaged with GRIHA Council to ensure that we build 'GREEN BUILDINGS'. A majority of AAI's upcoming buildings including new terminals at airports have been registered under various GRIHA rating variants. A few of them have already been rated.

I would like to take this opportunity to congratulate the GRIHA Council on the launch of the upgraded version of the SVAGRIHA rating. I wish GRIHA Council success in all their future endeavours and look forward to our continued collaboration in future.

Sanjeev Kumar 30/11
(Sanjeev Kumar)

शैलेंद्र शर्मा
महानिदेशक
Shailendra Sharma
Director General

सत्यमेव जयते

भारत सरकार
Government of India

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MESSAGE

It gives me immense pleasure to learn that GRIHA Council is bringing out its annual magazine 'Shashwat – Let Nature Be' during its annual flagship event – 'The GRIHA Event' on 10th December 2021 in New Delhi.

The theme chosen for the magazine – 'Restoring Green Economy' is contextually relevant and in line with the Government of India's efforts for achieving the Sustainable Development Goals.

Today the need for ensuring sustainability along with achieving developmental goals has the concern and attention of entire world. CPWD as a Principal Engineering Organization of Government of India is playing an important role towards sustainable and affordable development by adopting green construction practices in all its projects. Technical publications of CPWD are aligned with the National Building Code (NBC), Energy Conservation Building Code and GRIHA norms.

I take this opportunity to extend my deep appreciation to GRIHA Council for launching 'SVAGRIHA Version 3'- an updated version of SVAGRIHA (Simple Versatile Affordable GRIHA), developed exclusively to assess the environmental performance of smaller building with respect to current standards and norms.

I compliment GRIHA Council and extend my best wishes for their success.

(Shailendra Sharma)

अभय बाकरे, आईआरएसईई
महानिदेशक
ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

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

I am happy to learn that GRIHA Council is launching its annual magazine SHASHWAT with the theme "Restoring Green Economy". This theme chosen for the magazine has significant importance considering the current pandemic situation in our country, which has severely affected a majority of the economic activities.

High economic growth is mainly possible only with low per capita emissions for which Ministry of Power, Government of India wants to enhance energy efficiency and promote clean energy. The Union Government intends to lay a balanced emphasis on economic development and environment. It is adopting a climate friendly and cleaner path to achieve cleaner economic development.

In the efforts to control demand side energy management, the Government of India under the ambit of Energy Conservation Act, 2001 has been implementing various innovative policies. One of the significant policies among them in the building domain is the implementation of Energy Conservation Building Code (ECBC). In numerous States, it has been incorporated into the building bye-laws as a mandatory requirement to get approvals for construction. Additionally, the EcoNiwas Samhita developed for building performance evaluation is a simple and interactive tool to raise awareness and sensitize people for adopting energy efficiency measures in buildings and educate users with energy saving potential; cost savings and CO2 emission reduction.

I am happy to know that the GRIHA rating right from its inception has ensured that ECBC is a mandatory requirement to obtain the rating, thereby ensuring that it is in line with the national interests and hence reinforcing its name as the National Rating System for India. GRIHA's rating variant "GRIHA for Affordable Housing" is aimed at helping low-income housing projects to reduce their operational costs and GHG emissions.

I am also delighted to learn that the GRIHA Council will be launching their latest version "SVA GRIHA V3" rating, which has been designed exclusively for Smaller Buildings.

I wish them good luck in all future endeavours.

Abhay Bakre

(Abhay Bakre)

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Message from the President and Vice-Chancellor, UNSW Sydney, Australia

It is my pleasure to provide this message for Shashwat magazine and to express my congratulations to the GRIHA Council and TERI for their dedication to advancing India's sustainability agenda. It has been UNSW's honour to support you in this quest by drawing on our history of commitment to environmental science, renewable energy and the built environment.

The theme of this year's edition of the Shashwat magazine, Restoring Green Economy, resonates strongly with the mission of UNSW. It is imperative that we seek sustainable solutions towards economic recovery as the world struggles to mitigate the adverse effects of climate change and the devastation caused by the COVID-19 pandemic.

At the heart of UNSW's vision is a desire to have a positive global impact through education and the nurturing of innovation to rise to the challenges of the 21st century. Partnerships with local and global communities allow UNSW to share knowledge, skills and research outcomes.

I commend the GRIHA Council on its efforts to continually evolve its rating system to meet the changing needs of the built environment. The launch of the latest version of SVA GRIHA manual, a rating tool specifically designed for small buildings, is a prime example of GRIHA Council's endeavour to achieve sustainability across all habitats.

I look forward to hearing of the great outcomes that UNSW's collaboration with the GRIHA Council and TERI promises and how they bring hope and progress to our communities in the days ahead.

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Ex-Officio Secretary to Government
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September 6, 2021

'Shashwat' - the roots and spirit of the word rings true across languages. And for Kerala, the spirit of sustainability has been embedded in the state's development aspirations for a very long time. The efforts of Kerala Infrastructure Investment Fund Board (KIIFB) in the infrastructure space are a natural extension of this aspiration.

The possibility that over 60 % of the expected development footprint in Kerala over the next decade shall be funded by KIIFB is a responsibility like no other. That is the prime reason why KIIFB decided to partner with GRIHA Council - a pioneering initiative in Green Building Sector of India to ensure that all KIIFB funded buildings above 2500 Sq.m of Built-Up Area shall strive for a minimum of GRIHA 3-star rating.

Hence, it is indeed a matter of great satisfaction and happiness to see that GRIHA council is bringing out the 8th edition of "Shashwat-Let Nature Be" with the theme "Restoring Green Economy". The theme reflects the need of the hour especially considering the havoc brought about by the pandemic. Congratulations to the Council for selecting this theme.

I wish GRIHA council success in all the future endeavors

Dr. K M Abraham

CHIEF EXECUTIVE OFFICER, GRIHA COUNCIL

Dear Friends & Colleagues,

GRIHA is synonymous with green development in India. It has been a catalyst for the widespread adoption of sustainability in India and is seen as an effective agent of change in addressing issues related to resource efficiency, protection of biodiversity and the pressing need to reduce greenhouse gas emissions. It has evolved to evaluate resource efficiency in the design, construction & operations stages, catering to both new buildings and the existing built environment. The year has been one of green growth even in the face of adversity and I am pleased to see that the team at GRIHA Council has risen to the challenge of embracing the new normal and made a paradigm shift in its operations. With flexible arrangements, renewed protocols and a switch to virtual platforms, the Council enhanced productivity, along with ensuring people's health & well-being as well as that of the economy.

The COVID-19 pandemic arrived in India in early 2020 and has since then severely disrupted economic activities, caused a contraction in the GDP, and a significant loss of jobs. To combat the onslaught of the economy, countries are developing and implementing a range of expansionary fiscal and monetary measures. Some concerns have become pertinent to this process of economic recovery, the primary being how the economic stimulus can be made "GREEN".

Pursuant to this, I am pleased to announce that the theme for this year's GRIHA event and annual magazine SHASHWAT is "Restoring Green Economy". We aim to initiate a dialogue about taking decisive steps to go beyond the conventional GDP and measure it inclusive of green development. The acceleration of the global green transition to combat climate change and generate a sustainable economy and work force, are amongst the greatest and most imminent global challenges. A green recovery can ensure economic growth and investment while preserving environmental quality and ensuring social inclusivity. It is imperative that we direct our efforts towards leveraging knowledge and technology to not only build back, but build back better.

This event will echo the sentiment of the recently held climate summit COP26, which was intended to accelerate action for attainting the goals of the Paris Agreement with countries committing to enhanced nationally determined contributions. Considering COP26, it is felicitous to highlight the steps taken by India to move towards a carbon-neutral future. We have already lowered the energy intensity of our GDP by almost a fourth compared to 2005 levels. At the recent session of the UN General Assembly, India pledged to install 450 gigawatts (GW) of renewable energy by 2030, a promising step towards balancing both economy and ecology. GRIHA has been recognized by the Government of India, as a tool to evaluate greenhouse gas reduction from habitats under its obligations to mitigate climate change in the nationally determined contributions (NDCs) submitted to the UNFCCC.

The event will additionally provide a platform for the launch of SVAGRIHA version 3, which evolves from a design-cum-rating tool for small stand-alone buildings in each sector, to now include impact analysis which will enable project proponents to estimate the qualitative and quantitative impact of their buildings over its entire lifecycle. I take this opportunity to acknowledge our esteemed clients and industry associates with whom we have built inclusive partnerships based upon shared principles, values, vision, and goals. In these difficult times of economic slowdown, it is imperative to recognize the success and achievements of GRIHA and its many partners.

As of February 2021, a Memorandum of Understanding has been signed between GRIHA Council and the Kerala Infrastructure Investment Fund Board (KIIFB). This is the first time that GRIHA Council is being associated with an agency such as KIIFB, who mobilize and channel funds for facilitating planned and sustainable development of both physical and social infrastructure. Recognizing the significance of sustainable development of building infrastructure, both parties will work towards collaborative promotion and implementation of green building concepts and its evaluation using the GRIHA rating system in the state of Kerala.

The same month, a Memorandum of Understanding was also signed between GRIHA Council and the Confederation of Indian Micro Small and Medium Enterprises (CIMSME). CIMSME & GRIHA Council share a common vision of promoting sustainability in the built environment through energy efficiency, efficient building design & optimal use of resources. Under the ambit of this MoU, the organizations will work towards creating awareness on green buildings & GRIHA ratings, and will enable active dissemination of knowledge and skill necessary to design, construct and maintain a green building. I am also delighted to share that the United Nations Framework Convention on Climate Change in their third biennial update report 2021 on India has recognized GRIHA's work in the field of energy efficiency, site planning, conservation and efficient utilization of resources as the national green building rating system of India. We at GRIHA believe in the power of education and have launched the GRIHA Learning Centre early this year. The online centre has been developed as a massive step towards bridging the gap between green rating and sustainability integration with the aim of ensuring easy accessibility to green building knowledge to every individual across the nation. As we step into 2022, our resolve to constantly endeavour to make the world greener and sustainable for future generation is stronger than ever. We look to be among the frontrunners in reinvigorating the economy and spearheading our sustainability movement. On behalf of the GRIHA Council and our partners, I thank all our readers for their faith and confidence in our work which drives us to do more.

Season's greetings to all and my very best wishes for a happy and healthy New Year!

Sanjay Seth
Chief Executive Officer
GRIHA Council

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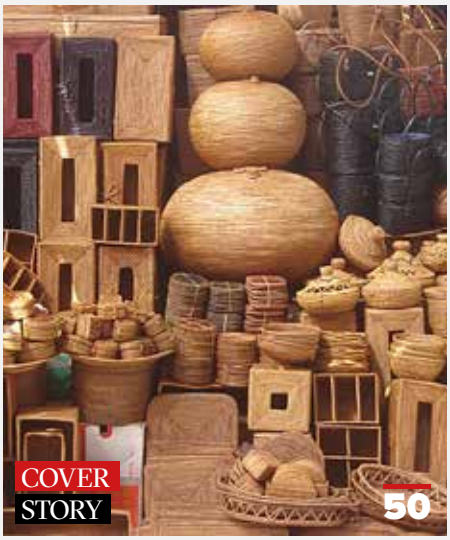

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BUILDLING BACK BETTER WITH BAMBOO

As one of the world's leading cultivators of bamboo, India shows promise in the engineered bamboo sector through climate-smart investment to build green infrastructure. In this timely piece, Shri Suresh Prabhu discusses how a positive financial investment is necessary for the bamboo industry in India to realize its potential as the key natural capital to accelerate the achievement of the 2030 Agenda and emissions reduction targets.

Shri Suresh Prabhu is a Chartered Accountant by profession. He is a 6-time MP and presently represents Andhra Pradesh in the Rajya Sabha. He was the Union Cabinet Minister of Civil Aviation, Commerce & Industry, Railways, Power, Heavy Industry & Public Enterprises, Fertilizers & Chemicals, Environment & Forests. Additionally, he was Chairman of the Task Force for Interlinking of Rivers. Mr Prabhu launched the India Bamboo Forum – an independent platform – with an aim to boost the bamboo sector by promoting entrepreneurship, research, and trade of high quality bamboo products in a sustainable manner.

Introduction

The developed and developing countries of the world tend to focus on economic growth at the cost of sustainability. Over the past few decades, multilateral and bilateral agencies such as the United Nations, The World Bank, European Union, and others have made sincere efforts to integrate sustainability in their respective growth models. National governments too have followed this lead. Unfortunately, these interventions have not led to a remarkable change in the development model.

The total disruption of global and local economies due to the COVID-19 pandemic has led to an unprecedented socio-economic impact. This scenario has presented an opportunity to assess the growth trajectory being pursued globally and call for a structural transformation of economic activities. The coronavirus outbreak has disproportionately affected the most marginalized and vulnerable populations across the world, thereby highlighting the importance of accelerating inclusive development.

'Build Back Better'

The UN's clarion call to 'build back better' must be taken seriously and implemented across sectors. A recent paper published by the

United Nations Environment Programme (UNEP), 'Are We Building Back Better: Evidence from 2020 and Pathways to Inclusive Green Recovery Spending', underlines the importance of investment in nature-based solutions. It highlights the critical role of natural capital for the achievement of the 2030 Agenda (specifically through goals 5, 6, 8, 13, 14, and 15) and the urgent need to meet emissions reduction targets through carbon sequestration in line with the Paris Agreement.

Bamboo has tremendous potential to provide nature-based solutions for 'building back better' in order to realize the mission and vision of 'Atmanirbhar Bharat'. It is the most environment-friendly plant that helps to sequester carbon among all floral species. It grows rapidly, matures within a few years, and regrows after harvesting without the need for replanting, thus making it a perennial 'renewable' resource. Bamboo also requires lower emission-intensive processes to create components for the construction industry. It needs one-third the energy compared to timber, one-eighth the energy compared to cement, and one-fiftieth the energy for processing equivalent mild steel. At the end of a bamboo product's life cycle, it can be recycled, repurposed, or burned to produce heat or electricity. Thus, compared to other materials, bamboo products have a low or even negative eco cost over the course of their life cycle.

Recognized for its eco-friendly characteristics, bamboo has found global acceptability as a key raw material in the building and construction industry, furniture and other wood-based sectors. The use of bamboo has a two-fold impact – one, it replaces the use of steel and timber; and two, it reduces deforestation and climate change risks.

Further, by creating a demand for bamboo, it ensures a steady supplemental income for farmers. Bamboo plantation offers additional benefits to farmers because it is an effective natural resource to control soil erosion, raise the water table, and improve fertility of even the most degraded soils. Bamboo plays an instrumental role in combating desertification by restoring degraded lands and protecting forests. Most bamboo species form an evergreen canopy, shedding leaves all year round, and this too, contributes to improving soil health. These species can be easily integrated into agricultural practices by growing them on farm boundaries and farmland as well as non-agricultural land including wastelands and degraded lands, and in homesteads too.

Promotion of Bamboo Plantation

The International Bamboo and Rattan Organisation (INBAR) is a multilateral development organization that promotes sustainable development through bamboo and rattan. It has 48 member

states. Its unique set-up makes INBAR an important representative for the member states. With over 40 member states from the Global South, INBAR has played a crucial role in promoting South-South cooperation for the last 20 years. Since its inception, it has made a significant difference to the lives of millions around the world, with achievements in terms of raising standards, promoting safe, resilient bamboo construction, restoring degraded lands, ensuring capacity building, and informing green policy and SDG objectives.

In 1998, as Union Minister for Environment and Forests, I took the lead to make India a signatory to the INBAR treaty. My Ministry took the initiative to start bamboo promotion in our country. In 2004, I also facilitated the establishment of a not-for-profit organization – Konkan Bamboo and Cane Development Centre (KONBAC) – in my constituency in the Sindhudurg district of Maharashtra. KONBAC, in partnership with INBAR, focused on the development of bamboo as a key resource for catalysing an inclusive green economy.

In 2020, I conceptualized the India Bamboo Forum (IBF) as a platform for leaders and stakeholders to come together to address systemic gaps that inhibit the growth of the bamboo sector. The Forum began with an aim to drive the green economy by generating livelihood opportunities.

Today, IBF has a membership of 60 leaders across the bamboo value chain, such as farmers, foresters, entrepreneurs, architects, designers, contractors, R & D organizations, skilling institutions, academic organizations, bankers, machinery suppliers, and primary and secondary producers. Our resolve is to encourage all stakeholders to come together on one platform to share, deliberate, and resolve the challenges faced by the bamboo sector.

A few IBF members have not only demonstrated the viability of bamboo-based enterprises but also the competitiveness of Indian bamboo-based initiatives in global markets. These industries cover construction, furniture, interiors, lifestyle accessories, and so on.

A positive financial investment is necessary for the bamboo industry in India to realize its potential as the key natural capital to accelerate the achievement of the 2030 Agenda and emissions reduction targets through carbon sequestration in line with the Paris Agreement.

In this regard, SDG500 is a global impact investment platform dedicated to financing the SDGs. It offers exposure to six impact funds targeting businesses in the agriculture, finance, energy, education, and healthcare sectors in Africa, Asia, Latin America, and the Caribbean and Pacific regions. With a fund of US$50 billion for sustainable start-ups, the gaming giant Razor invested in 'Bambooloo' – a company that manufactures toilet paper from bamboo.

The Indian government estimates that the country needs to spend 7–8% of its GDP on green infrastructure each year, which is equivalent to an annual investment of US$200 billion up to 2030.[1] The International

[1] For more information, visit https://www.orfonline.org/research/a-green-investment-architecture-for-india-building-a-bridge-for-global-capital-67192/

Finance Corporation (IFC) estimates for climate-smart investment are even higher – at US$3.1 trillion up to 2030 – implying an annual investment of US$300 billion.

Currently, the Government of India has instituted the National Clean Energy Fund (NCEF) to promote clean energy and to take initiatives through funding research and piloting innovative projects.

The Indian industry and financial institutions have always assumed leadership roles and worked with the government for economic growth to provide livelihood opportunities to the people, especially during crises. For instance, the COVID-19 pandemic demands that all public, private, and civil society stakeholders unite to overcome the challenges faced by our country.

The UN's clarion call 'to build back better' gives our country an opportunity to innovate in terms of building a sustainable inclusive economy and creating livelihood opportunities, especially for rural populations. These populations have been the most vulnerable due to the disruption of our economy owing to the COVID-19 crisis. The lack of employment opportunities in their own villages compelled them to migrate to urban and industrial centres. Low skills enabled only low-wage labour opportunities, thereby forcing them to live in inhospitable conditions in slums that had adverse effects on their well-being, leading to a vicious cycle of low productivity, insecure employment, and low wages. Reverse migration to villages further impoverished these populations. The data on the COVID-19 pandemic clearly indicate that low-income, marginalized communities bearing low socio-economic and health indicators were severely affected.

The 'build back better' model of economic development with a focus on natural capital is premised on the revival of rural economy through the creation of livelihood opportunities for rural populations while ensuring their security and well-being. In this regard, bamboo has the potential to be a key driver for agro-industrialization due to its low dependence on high technology or infrastructure, its easy availability in rural areas, and accessibility of local labour. Further, bamboo clusters can be developed as hub and spoke models with technology-enabled, high-skill processes being undertaken at the hub and primary processing at the village level. This dispersed model of production would lead to promising employment opportunities for rural communities across the country.

Engineered Bamboo Products and the Way Forward

One of the key commercialized bamboo products with a booming domestic and global market is engineered bamboo. This is used for making structural components for construction and building, flooring, roofing, furniture, interiors, and lifestyle accessories. KONBAC's success, as mentioned earlier, in building structures of high and aesthetic quality while guaranteeing value for money in India and overseas has also demonstrated the competitiveness of the Indian bamboo sector in the global construction and building industry.

Unfortunately, entrepreneurs in the bamboo sector are unable to benefit from the stable and growing markets for engineered bamboo. The reasons are a weak supply chain and absence of a robust financial and technical ecosystem required for the establishment of the engineered bamboo industry. The farmers are unwilling to grow this non-traditional variety of bamboo required for high-value products because there is no assured market for their produce. Moreover, entrepreneurs are unable to manufacture high-value engineered bamboo due to the unavailability of the required species. Further, a farmer perceives bamboo to be a low-value material used for scaffolding and temporary farm structures. Thus, farmers are not motivated to invest in learning the scientific processes of bamboo plantation, its growth, and harvesting, thereby leading to poor quality harvests that yield lower rates. This creates inefficiencies that lead to the stagnation of the bamboo sector. Moreover, this sector is unable to capitalize on the achievements made in the construction and building industry. The barriers in the setting of technical standards for 'ground plus one (G+1) structures' by ISO (International Organization for Standardization) include lack of domestic support for the use of bamboo and its components.

Therefore, there is an urgent need for the industry and financial institutions in India to come forward and promote research and development in the bamboo sector to create an ecosystem for the uptake of bamboo-based components as industrial raw material. We must lead by example to enable our country to 'build back better'.

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Prof. Ashwani Pareek
Chief Executive Officer, Center of Innovative and Applied Bioprocessing

"The Center of Innovative and Applied Bioprocessing (CIAB)– an autonomous institute of the Department of Biotechnology, Government of India–is the only institute in the country which works predominantly in the areas of secondary agriculture and development of value-added products from different types of bioresources.

The CIAB campus, with a built-up area of 7823 m^2, has been provisionally certified with a 'Four Star' rating under GRIHA (Green Rating for Integrated Habitat Assessment). Due diligence visits were conducted by GRIHA officials during different stages of construction and post the occupancy of the building.

CIAB had a rich learning experience with the GRIHA team. All the members involved in the project were instrumental in the design process. They worked towards implementing the sustainability features in the building.

Our association with GRIHA will inspire others in the field to take a step forward to bring 'green' changes in the construction industry. We found the rating system to be well-structured and suited to the Indian context. It addresses technical design issues and also evaluates post occupancy performance, which we feel is practical and the need of the hour. The rating system helps optimize the design philosophy and lends it character while keeping the intent of the process intact. Moreover, the sustainability factors encourage the designers to move in the right direction by helping them create an eco-friendly and a sustainable building."

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Significance of Eco-Inclusive Enterprises in Construction Sector

In this article, Nilay Srivastava, Amarnath Munnolimath, Prahlad Tewari, Dr Vidya S Batra, and Dr Malini Balakrishnan discuss the relevance of eco-inclusive MSMEs in fostering sustainable production and consumption, thereby directly contributing to SDG 12 ('ensure responsible consumption and production') and overall green growth in the construction sector.

Nilay Srivastava works in the Resource Efficient Technologies area at TERI that hosts the SEED India Hub. He supports the implementation of Hub activities by ensuring technological support to eco-inclusive enterprises and working towards the overall expansion of the network of such enterprises in the country. He can be reached at nilay.srivastava@teri.res.in.

Amarnath Munnolimath has been involved in SEED since 2013, and he heads the SEED Global enterprise support programmes covering the SEED Awards, Starter, Catalyser, and Business Development Support. Further, in his role as Senior Manager at adelphi, he manages development projects with Asia and Africa covering resource efficiency, circular economy, waste management, green finance, and entrepreneurship. He can be contacted at a.munnolimath@seed.uno.

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Dr Vidya S Batra is Senior Fellow at TERI providing coordination support to the SEED India Hub. She has expertise in research, technological development, and scale up, particularly on value-added utilization of industrial wastes for energy and environmental applications. She also supports MSMEs in their implementation of resource-efficient cleaner production measures. She can be reached at vidyasb@teri.res.in.

Dr Malini Balakrishnan is Senior Fellow at TERI engaged in coordinating the SEED India Hub activities in collaboration with SEED Global at adelphi. She has a vast experience in research, development, and assessment of technology solutions focusing on affordability and suitability in the context of developing countries. She has also directed collaborative projects targeted at implementing resource-efficient measures in MSMEs in South Asia. She can be reached at malini.balakrishnan@seed.uno.

Background of Eco-inclusive Enterprises

Operating on profitable business models that are socially inclusive and environmentally beneficial, eco-inclusive enterprises offer a wide range of products and services encompassing various sectors such as infrastructure, energy, waste management, and sustainable agriculture among others. Often falling in the micro, small and medium enterprises (MSMEs) category, these endeavours are crucial in climate adaptation and mitigation, helping build resilient and adaptive community structures (SEED Global 2021; OECD 2018). Consequently, they play a significant role in contributing towards achieving the country's Sustainable Development Goal (SDG) indicators and Nationally Determined Contributions (NDCs) with noteworthy effects on the triple bottom line. The triple bottom line approach addresses the business, social, and environmental dimensions of the enterprise as follows:

- **Economic viability:** As per the Organization for Economic Cooperation and Development (OECD), MSMEs ensure job prospects to four billion people living below the poverty line, representing a global market opportunity worth US$5 trillion (ITC 2018). In most national economies, SMEs are responsible for 90% businesses and account for 50% employment (GEC 2020; IMF 2020). Furthermore, they form a vital component of the supply chain for large industries and corporates.
- **Social inclusivity:** These enterprises help underserved communities by providing them basic services such as affordable goods and services, skill development, and awareness generation, while promoting youth empowerment and gender equality. In informal economies, globally, these are sources of livelihood for low-income groups. Since most peri-urban and urban communities rely on MSMEs for employment and economic activities, their decline can lead to job losses and forced migration (IMF 2020).
- **Environmental sustainability:** This aspect is addressed by implementing resource-efficient measures through the use of renewable energy sources and waste/secondary raw materials in the products, thereby minimizing waste generation and reducing pollution levels. Through the delivery of green products and services, eco-inclusive MSMEs foster sustainable production and consumption (SCP), directly contributing to SDG 12 ('ensure responsible consumption and production') and hence to green growth.

Examples of Eco-inclusive Enterprises in the Buildings and Construction Sector

The examples described in this section are part of the SEED initiative,[1] which is a global partnership for action on sustainable development and green economy. SEED was founded at the 2002 World Summit on Sustainable Development in Johannesburg by UN Environment, United Nations Development Programme (UNDP), and International Union for Conservation of Nature (IUCN). Currently supported by International Climate Initiative (IKI) and German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Government of Flanders, SEED Global is hosted at adelphi research, based in Berlin, Germany. The India Hub for SEED, inaugurated in 2020, is anchored at The Energy and Resources Institute (TERI).

1 For more details, visit the official website of SEED: https://seed.uno/

It is well recognized that to conserve and preserve valuable natural resources along with our biodiversity for future generations, active support for a circular economy transition is required. The enterprises supported at SEED are proving their transformative potential of business models driven by social, economic, and environmental sustainability objectives. These successful businesses cover themes such as upcycling and recycling, resource efficiency, and creation of innovative products and services.

Case Study 1: RecycleX Private Limited,[2] India

In 2020, this Gujarat-based enterprise was established in Bharuch, which converts waste plastic, industrial waste, construction and demolition debris into eco-friendly recycled sand and aggregates to create a range of building materials including paver blocks, kerbstones, bricks, tiles, etc. The premium price is offered for plastic and other wastes that are transformed into value-added building materials to create rural infrastructure (e.g., benches, roads, toilets) (Figure 1). The unit has 30 full-time (including 20 women) and 20 part-time employees. So far, 6 tonne plastic waste, 50 tonne industrial waste, and 25 tonne construction waste have been recycled, thereby saving up to 1.8 kg CO_2 per ft² paved with recycled material. The enterprise also plants a tree for every 1000 ft² recycled material manufactured.

[2] For more details, visit https://www.seed.uno/enterprise-profiles/recyclex-private-limited;%20https://www.recyclex.in/

» **Figure 1:** Building materials from various wastes (a) paving bricks made of plastic and industrial waste (b) pavement made from waste-based paving bricks

Case Study 2: EcoBrick Exchange, South Africa[3]

Ecobricks are thermally insulating bricks fabricated by compressing unrecyclable plastic into bottles (Figure 2). This enterprise, established in 2013, strongly engages with local businesses and users, educating local communities on manufacturing these ecobricks to construct community buildings, such as pre-schools and early childhood care centres. Local residents benefit from exchanging bricks for used household goods or discounts at stores, while reducing household waste and cleaning up the streets. Each brick saves approximately 0.3 m³ of packed garbage from streets and landfill, or 3 kg worth carbon emissions from burning garbage.

» **Figure 2:** Ecobricks made using plastic waste

Case Study 3: EcoAct, Tanzania[4]

This enterprise processes plastic waste sourced from both local partners dedicated to reducing plastic pollution as well as low-income households into durable, affordable plastic timber for construction. Plastic timber is an alternative to wood (Figure 3), which reduces construction costs, thereby creating savings among low-income households. The enterprise focuses on generating job opportunities

» **Figure 3:** Plastic timber

[3] For more details, visit https://seed.uno/enterprise-profiles/ecobrick-exchange

[4] For more details, visit https://seed.uno/enterprise-profiles/ecoact-tanzania

for youth and widows. Recently, it launched a micro health insurance programme, 'Garbage Medical Insurance' for 50 low-income households and slum dwellers in exchange for plastic waste. Additionally, a mature red cedar tree was adopted for every 25 plastic timber sold. Till now, such efforts have diverted 360 tonne plastic waste from landfill annually, saved 4500 tonne CO_2 emissions, and prevented deforestation threat to forests of 650 acre area.

Case Study 4: Hustlenomics, South Africa[5]

Hustlenomics, established in 2015, provides sustainable housing options by replacing the informal housing shacks of low-income homeowners with durable structures using recycled bricks (Figure 4). It works on an innovative shared-home financing model where the rental income generated from the finished structure is used to recoup building costs before eventually obtaining full ownership. It also provides employment opportunities to the vulnerable members of local communities through training programmes on skill development in sustainable construction methods.

Summary and Outlook

This article highlights the success of small businesses promoting waste-based alternative building materials. Besides being profitable, such enterprises play a crucial role in engaging with local communities and providing employment to vulnerable groups, such as marginalized youth and women. These enterprises also contribute towards actions directed at climate change mitigation. Recognizing their significance, the SEED programme aims to scale up such climate-smart enterprises by working closely with public and private sector partners through a two-pronged approach to enterprise development consisting of 'Direct Enterprise Support' and 'Ecosystem Building' programmes. SEED supports enterprises from the early stages of inspiration to the acceleration, scaling up, and replication of proven eco-inclusive business models. The programme also cultivates an ecosystem for the success of such enterprises by building a network of collaboration, financing and policy opportunities.

The SEED Hub at TERI is working towards facilitating an eco-inclusive entrepreneurship culture in India. Using tried-and-tested instruments and support mechanisms, the Hub has, till now, rolled out several programmes supporting climate-smart enterprises.

» **Figure 4:** Recycled bricks (a) sample (b) manufacturing facility

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Restoring Green Economy

Is India Ready for Electric Vehicles?

In this article, Ar. Sushant Jaganade highlights the future of EVs in India and discusses the challenges that must be overcome to make this mode of transport a viable and sustainable option in the automobile sector. The stakeholders must develop a road map to make at least 30% vehicles electrically powered by 2030, according to the target announced by the Indian government. But, is India ready for the transformation?

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Introduction

Transportation has played a crucial role in the advancement of humanity. The invention of the wheel led to other significant technological developments. Today, wheels too are being replaced by drones that can fly and land on their own. Conventionally, we humans have been using fossil fuels to run different modes of transportation. This was not an issue until early 21st century, which is when the need to conserve natural resources became a global concern. In recent years, due to global warming, climate change risks, and the urgent need to realize the sustainable development goals (SDGs), the world has been compelled to turn to alternative sources of energy and the best available resource is electricity. The electric-powered vehicles, for instance, are beneficial in all aspects when compared to conventional vehicles. However, given the present infrastructure conditions, is India ready for electric vehicles (EVs)?

Choosing Green Fuel

In September 2017, Nitin Gadkari, India's minister of Road Transport and Highways announced that all of India's approximately 250 million vehicles must be electrically powered by end of 2030 (Carpenter 2019). Later, after receiving serious criticism, the government revised its stand and altered the target from 100% electric vehicles to 30% by end of 2030. The question however, is, what is the immediate rush to go for green fuel? In 2015, approximately 385,000 premature deaths caused by tailpipe emissions were reported worldwide out of which 75,000 cases were from India. About 70% of the impact was caused by the four major vehicle markets, i.e., China, India, US, and Europe (Miller 2019). The major reason attributed to the adverse effects on human health is the PM2.5 emissions from diesel-run vehicles. The PM2.5 factor is responsible for 50% deaths world over out of which 75% of the cases get reported in India.

Impact of Tailpipe Emissions on Human Health

Let us investigate the need for alternative fuel in the transport sector. Conventional vehicles are operated by diesel engines which have severe effects on human health including high mortality risk, exacerbation of asthma, chronic bronchitis, respiratory tract infections, and stroke. Diesel-operated vehicles perform incomplete combustion, thereby resulting in the formation of gas, liquid, and solid particles. Compared to petrol-run engines, diesel cars emit fairly less amount of carbon monoxide but they do release nitrogen oxides and aldehydes which are particularly harmful to the upper respiratory tract. The particulate matter from diesel combustion travels 10 times higher than the petrol engines and this is a grave concern (Sydbom, Blomberg, Parnia, et al. 2001).

Ongoing Strategies to Reduce Combustible Pollutants

In April 2020, the Indian government launched Bharat Stage (BS)-VI engines for automobiles running on conventional fuel. This enabled the automakers to compete with the European emission standards. Earlier, the BS-IV engines produced more particulate matter than BS-VI and yet, vehicles running on BS-IV are more in number than that operating on BS-VI. The impact of BS-VI engines has enabled the reduction in nitrogen oxide by 70% and PM2.5 and PM10 by a staggering 80%, which are major cancer-causing substances (Sinha 2019). The engines manufactured in adherence to BS-VI norms are eco-friendlier, more refined, and are cleaner with better fuel efficiency. The introduction of BS-VI engines has also increased the sale value of the vehicles by ₹10,000–30,000 for petrol and diesel-run vehicles. Therefore, though the development of BS-VI engines has come at an additional cost, it was the need of the hour.

Shifting to Electric Vehicles

Global warming concerns have created an urgent need for reduction in fossil fuel use and associated emissions. India has promised to cut down its GHG by 33–35% below the 2005 levels by 2030. With people shifting from rural to urban areas, there is an added stress on the energy and transport industry resulting in higher levels of air pollution. Though urbanization is important for a

country's economic development, there must be limits set on the usage of the available resources so that stocks do not dry up for successive generations. According to a report submitted by WHO, India is home to 14 out of 20 most polluted cities in the world (NITI Aayog 2018). Vehicles dependent on fossil fuels rely on an expensive supply chain and that further gets impacted by external factors, such as weather conditions, geopolitical location, and extreme events among others. India imports 80% of oil to sustain its stock of fossil fuels. The rising fuel charges have pushed the acceptance of EVs more than ever. Due to these factors, countries such as US, Europe, Japan, China, and even India have included the introduction of EVs in their policy to lower their respective rates of carbon emissions to ensure cost-effective mobility. As per statistics, out of 6.5 million private EVs operating globally, the major share belongs to China (37%), followed by US (24%), Norway, France, Germany (5% each), UK and Netherlands (4% each), Japan (3%); and the rest of the world stands at 13% (IEA 2020). This clearly indicates that India is still far behind in terms of adopting EVs.

Challenges

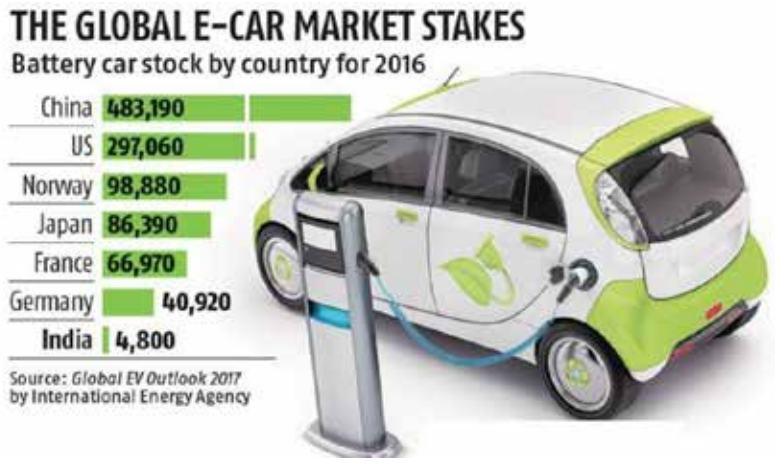
Apart from the lack of charging stations and necessary road infrastructure, EV owners would require additional space to charge their vehicles. The major worry is the lack of affordable renewable energy which puts coal-operated power supply stations under tremendous pressure. Thus, even after adopting EVs, we will not be able to eliminate the use of fossil fuels completely. Range anxiety is another serious hurdle to overcome. The current scenario suggests that India's existing technology is still not competent enough to manufacture EVs on a large scale, which is why their affordability is a serious concern (Gupta 2021). Additionally, switching to EVs for last mile connectivity is a long way ahead. In the metro cities, public transport is governed by buses, cabs, and autorickshaws which run on internal combustion engines (ICEs). This has, to some extent, been solved by the upcoming metro rail transits in Mumbai, Delhi, Bengaluru, Pune, Nagpur, and other parts of the tier-I cities. However, other transportation modes are still a long way from becoming electrified.

Opportunities

Companies like Tata Motors have been already rolling their cars in the EV sector since 2020, and the move is steadily becoming popular in the Indian automobile market. The two-wheeler (not the four-wheeler) in the EV segment has gained currency in India in the last five years. Many state governments are

also offering subsidy on the purchase of EVs. The Maharashtra government, for instance, has offered ₹31,000 on the newly launched Revolt bike, thereby encouraging the customers to buy more EVs (Darukhanawala 2021). This is a clear indication that if policymakers lend necessary support to EV customers, more people would be willing to ride these vehicles. This will also ensure sustainable mobility growth in the city. Moreover, the maintenance of an EV is 50% more economical than an ICE vehicle. After studying the Indian automobile market, customers are concerned about mileage and maintenance issues. If a company caters to these aspects then it has a great chance to succeed in the Indian automobile sector.

The Ola (ridesharing) company has set up a state-of-the-art and sustainable factory, spread over an area of 500 acre in Tamil Nadu, to manufacture electric scooters. The fully operational setup is expected to manufacture 10 million scooters per annum. The company is not only ready to manufacture EVs but it is also preparing to set up adequate charging stations. The company is planning to have one lakh charging stations across 400 cities. These are fast-charging stations with names such as 'Hyper Charger' (Electric n.d.). Consequently, the company reported over one lakh bookings in a span of 24 hours after opening their option to book. Ola claims to have received one lakh booking orders for its upcoming e-scooter in 2021 (ETAuto 2021). Therefore, the Indian population seems willing to switch from ICE to EV, at least in the two-wheeler segment. As more and more companies adapt to this technology, aided by incentives from the state governments, there will be more employment opportunities ensuring a boost to the country's economy.



Conclusion

The EVs do bring a lot of advantages to the mobility transport sector and they will definitely enhance the future of sustainable transport. India is ready to adapt to EVs in the two-wheeler segment more quickly than the four-wheeler and commercial vehicle sectors. The other transport segments will eventually adopt this technology once the infrastructure is ready. The positive outcome is that the central and state governments are helping in policymaking decisions to support the adaptation of EVs in the Indian automobile market. Consequently, this move will pave the way for acceptance of more and more EVs by 2030.

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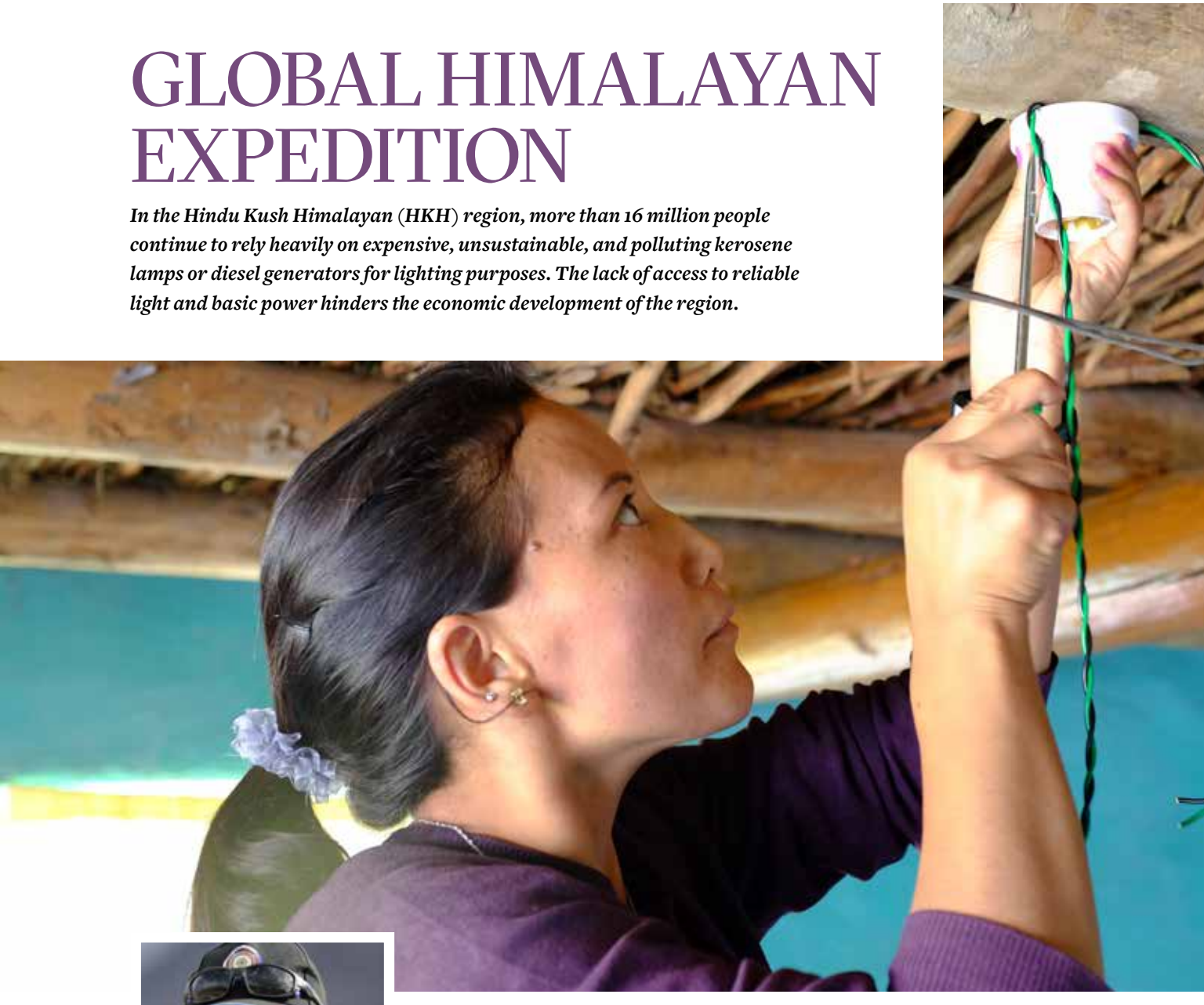
GLOBAL HIMALAYAN EXPEDITION

In the Hindu Kush Himalayan (HKH) region, more than 16 million people continue to rely heavily on expensive, unsustainable, and polluting kerosene lamps or diesel generators for lighting purposes. The lack of access to reliable light and basic power hinders the economic development of the region.



The Global Himalayan Expedition (GHE) is an Indian social enterprise that was founded in 2013 by Paras Loomba. The enterprise leverages tourism to provide clean energy access through solar power to the remote un-electrified off-grid communities of Ladakh, which is one of the most elevated and coldest inhabited regions in the world. To make this possible, GHE organizes leadership expeditions to remote villages where tourists, as part of their trip, not only experience the beautiful Himalayan trails but also help set up solar micro-grids in these difficult locations. This is how they leave behind a legacy after their visit and set an example for future tourists.

Within eight years after its inception, GHE has electrified over 150 villages in the remote regions of the Himalayas that now have access to clean and renewable energy, thereby directly impacting the lives of 100,000 residents. In the process, 1300 travellers from 60 different countries have been part of such impact adventures. Through the use of solar energy, the project has displaced 35,000 tonne CO_2 emissions till date. For this feat, GHE was recognized by the UNFCCC in 2020 as the first-of-its-kind tourism organization that conducts climate-positive and sensitive expeditions.

Solar electrification is just the starting point. To enable sustainable development of these villages, GHE helps indigenous communities to create livelihood opportunities through their own initiative called 'Mountain Homestays'. Such a concept helps connect remote areas, such as the Himalayas to the outside world, as part of which locals offer their homes as guest houses to the tourists. Operational since the last three years, the concept has helped promote as many as 60 homestays across 25 villages in Ladakh. By bringing in employment opportunities to their doorstep through electrification and tourism opportunities, GHE not only empowers the local womenfolk but also prevents migration of people from these hamlets to nearby towns for search of better job opportunities. This has not only reduced the frequency of migration but has also led to the preservation of age-old cultural heritage. The younger generation now tends to frequent the villages more often and act as tourist guides too.

However, the COVID-19 crisis compounded the problems faced by these communities. Currently, the absence of a basic healthcare infrastructure creates a serious impediment for the villagers, thereby lowering the confidence of the travellers to visit these offbeat destinations.

Some of the future initiatives by GHE are as follows:

Designing solar-powered health centres: The priority is to enable the local communities with access to healthcare facilities near their villages. This involves solar powering of the primary health centres and setting up of solar-powered medical appliances, such as vaccine carriers, medical refrigerators, ventilators, and other necessary medical equipment to provide immediate healthcare assistance to the communities. This will not only save much time and effort but also reinstil confidence among the communities and travellers regarding health and safety issues.

Future-proofing local communities: The COVID-19 pandemic has caused extreme distress to the local communities in terms of water availability and access. In order to ensure hygiene and hot water availability for regular home activities, such as cooking, washing of clothes and utensils, GHE has set up 130 solar water heaters across 45 Himalayan villages. The solar water heaters minimize the mounting pressure that locals could end up putting on the environment by burning excess fossil fuels and animal dung for heating water. This will also enable productive utilization of the time saved in searching for fuels. Going a step further, GHE plans to set up more than 150 carbon-neutral homestays across several remote villages with the vision of empowering local communities to be self-sustainable.

Lighting and Ventilation Issues in SRA Buildings

In this article, Ar. Ankur Kulkarni and Ar. Niranjhan Dakshanamoorthy bring to focus the merits and demerits of Slum Rehabilitation Authority (SRA) schemes in Mumbai. Are the living conditions in SRA buildings suitable for the rehabilitated communities? Are these buildings equipped with adequate daylighting and cross-ventilation facilities? These are some of the pertinent questions that the authors ask and find answers to in this timely piece.

Ar. Ankur Kulkarni is Principal Consultant at Kaizen Design Solutions with several years of experience in sustainable building design principles and high-performance building design. Working in the field since 2008, his focus area has been green buildings. He holds a Master's degree in Sustainable Architecture from Bharati Vidyapeeth University, India.

Ar. Niranjhan Dakshanamoorthy has been working in the industry since 2017 and has focused his energies into project building facilitation. He has a Master's degree in Sustainable Architecture.

Mumbai, the capital of Maharashtra, is one of the largest metropolitan cities with many slums in varying sizes. Every year, millions of rupees are spent on the resettlement and rehabilitation of slums to make Mumbai a sustainable living place for the marginal and below poverty line population. As per the official survey conducted by Mumbai Municipal Corporation in 1956, 8% of the total population was living in slums. According to Census 2011, the population of the city was 1.24 crore. Out of this, 41.85% of the population lived in slums and the numbers are only increasing with each passing day. According to reports, about 6% of the total land holds nearly 60% of Mumbai's entire population. Due to economic reasons, the slum dwellers are compelled to live in unhealthy and unsustainable conditions.

To overcome this crisis, in 1995, Slum Rehabilitation Authority (SRA) schemes were launched by the government of Maharashtra to facilitate slum rehabilitation tenements, which were provided to the slum dwellers for free. The objective of the government to rehabilitate the slum dwellers was successfully achieved through these schemes. Eventually, the SRA formulated and implemented similar schemes. Though these schemes achieved the objective of providing basic housing facilities to the poor, the settlements developed for such schemes failed to improve the quality of life in the provided shelters. Most of the SRA buildings had inadequate daylighting and poor natural ventilation. A survey

conducted by Mumbai Metropolitan Region Development Authority (MMRDA) with Doctors for You Association stated that the occurrence of tuberculosis was strongly associated with the built environment of the houses and the layout of the buildings. The outbreak of the disease was found to be least in those colonies with a better built environment and layout characteristics.

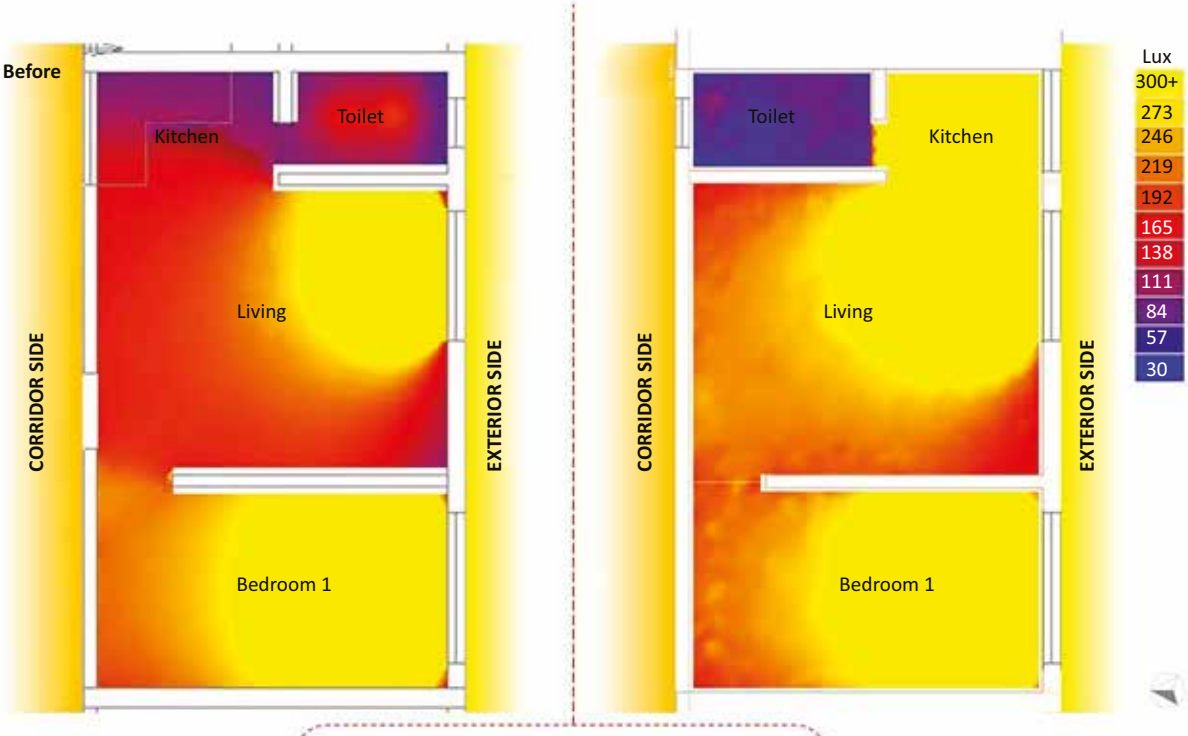
This article argues that efficient daylighting and ventilation strategies are important factors that affect human health and living conditions within a particular space.

Factors Affecting the Living Conditions

Density: The gross density for residents is nowhere higher than 1700 persons/hectare in Mumbai. This is despite not having enough land set aside for amenities and open spaces. Such a high demand created the need for high-rise SRA buildings. According to the survey conducted by Doctor for You Association, the SRA buildings lacked in performance and failed to meet the standard of living in terms of lighting and ventilation when packed close to each other. The major reason that contributed to such a scenario was the presence of highly dense and compact buildings.

Improper Planning: This has affected the performance of the SRA buildings. The compact arrangement of buildings in case of group developments has led to inadequate natural light and ventilation. The distance between two buildings should be sufficient to allow enough light to penetrate deep into the ground floor for better air movement in the surroundings.

Continuous ventilation in the kitchen area is a basic requirement of efficient



Space	SP 41	Achieved
Living	50	220
Bed 1	152	265
Kitchen	200	120

The window opening of Kitchen is provided in corridor, due to which it does not receive the requirement amount of daylight and ventilation. On flipping the position of Kitchen with Toilet, the Kitchen can have direct opening and a duct can be designed for Toilet Ventilation. This results in better daylighting and natural ventilation for Kitchen.

Space	SP 41	Achieved
Living	50	245
Bed 1	152	265
Kitchen	200	300+

» **Figure 1:** Daylight simulation for proper planning of inner spaces

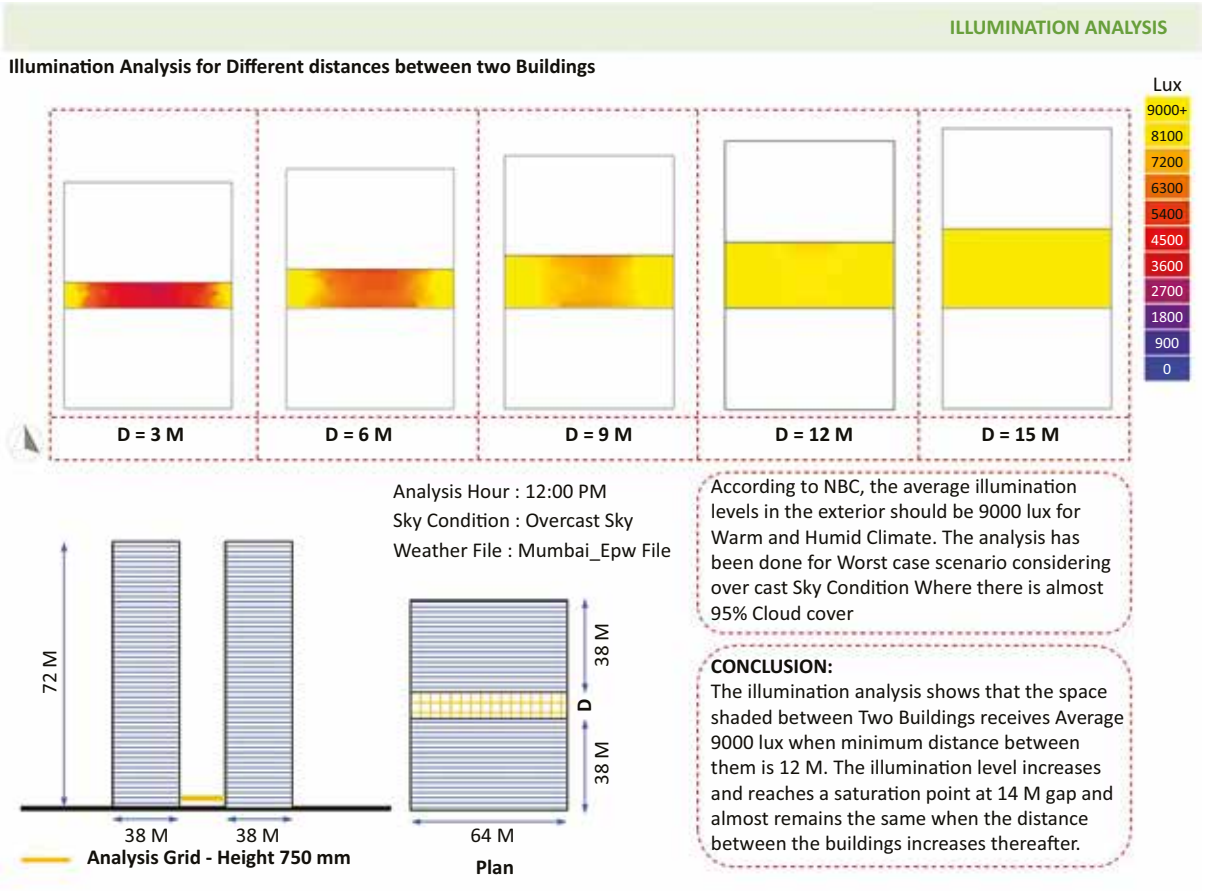
design. When there is inadequate or no fenestration, the air changes do not occur properly and the smoke from the kitchen remains stagnant for a longer period. The provision of openings in the kitchen and towards the corridor was observed in several SRA projects as given in Figure 1. This led to the accumulation of foul odour in corridors, resulting in the perceived notion that SRA buildings are poorly maintained with foul-smelling corridors.

Interchanging the positions of the kitchen and the toilet would help increase the lighting levels in the kitchen. As a result, the ventilation rate inside the space would also go up.

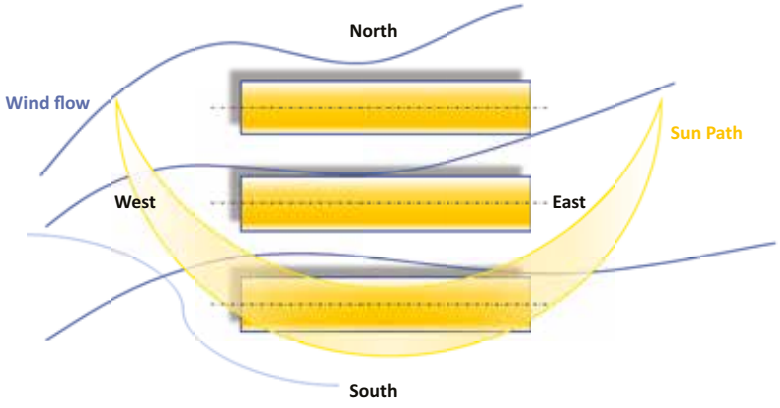
Ways to Mitigate

SRA and PAP project developers should follow NBC (National Building Code) norms for the rehab buildings without any discrepancies. According to NBC 2016, the recommended design sky illuminance values are 9000 lux for warm and humid climate. For the integration with artificial lighting during daytime working hours, an increase of 500 lux in the recommended sky design illuminance for daylighting is suggested. This shows that outside the building, there should be a minimum of 9000 lux at the lower floor in the design to meet the standard of sufficient lighting inside. Based on this, the gaps between the buildings should be simulated to check the minimum clear distance required to achieve the design sky illuminance values (Figure 2).

According to Special Publication (SP) 41, the minimum daylighting levels required inside the living room, bedroom, and kitchen are 50 lux, 152 lux, and 200 lux, respectively. According to NBC, the design should be checked for the minimum air changes per hour (ACH) achieved. This will ensure that the requisite standards for the dwellings are fulfilled. The minimum ACH required for the bedroom is 2–4 ACH and for the living room is 3–6 ACH.



» **Figure 2:** Illumination analysis for clear distance between two buildings



» **Figure 3:** Building orientation

Design: The orientation of the building's longer façade along the north-south direction will reduce the heat gain inside the buildings (Figure 3). Thus, the total radiation received by the building mass will be reduced. The wind flow will be in a near-parallel range with the building's longer axis and will increase the ventilation rate inside the building volume.

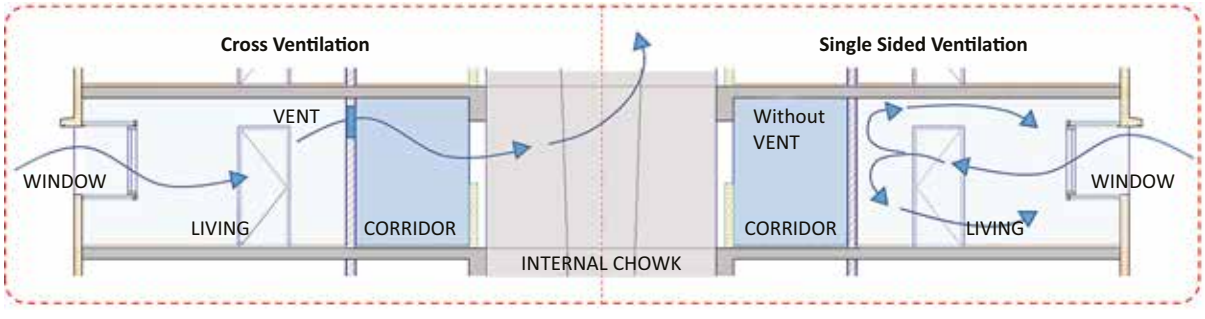
The spatial design should be efficiently planned by the architects in order to meet the building standards. Avoiding rooms and spaces without adequate openings for daylight and ventilation is the best strategy. Maximizing the window openings for better intake of sunlight and openable areas will ensure proper ventilation inside the space. Taking into consideration the surface reflectance of the interior surfaces and the visual light transmittance (VLT) of the window's glazing will ensure the deep penetration of the light into the inner spaces. According to the previously discussed norms, maintaining a proper distance between two buildings will guarantee enough daylight availability at the lower floors and better air movement.

Cross-ventilation: This should be taken care of by providing windows on either side of the rooms which continues to be a lacking area within SRA schemes. SRA buildings are mostly designed with one-sided ventilation. This affects the ventilation rate of the building space and air circulation inside the space. Cross-ventilation ensures that the building is naturally ventilated, thereby improving the overall ACH. At least, ventilator provision must be given to improve the movement of air within the space as shown in Figure 4.

The introduction of jaali over windows could be an efficient feature to reduce the incoming air temperature using the the funnel effect. The addition of an internal chowk inside the building volume increases the cross-ventilation rate of the building.

Wing walls: These are projections on the exterior wall to effectively enhance the natural ventilation. When properly positioned, the wing walls produce high pressure and low-pressure regions on the inlet and outlet windows, respectively. Hence, this helps to draw in more wind even during low external wind velocity conditions.

Light wells: These are external spaces provided within the volume of a building to allow light to reach the darker or unventilated areas. Light wells are commonly characterized by highly reflective surfaces. The provision of light wells will significantly improve the quality of lighting and ventilation inside the building space, thus illuminating the darker spaces inside the building.



» **Figure 4:** Cross-ventilation and single-sided ventilation

Solar reflectors: These can be used to increase the lighting by helping it penetrate into those spaces which are shaded due to external factors. In the gaps between two SRA buildings, which are closely packed, these reflectors can be used to light up the existing SRA buildings (Figure 5) if they do not meet the sufficient amount of daylighting levels. With these reflectors installed on top of the building, the ventilation shafts can also be lit to ensure that adequate light reaches the corridors and corners deep down the shafts.

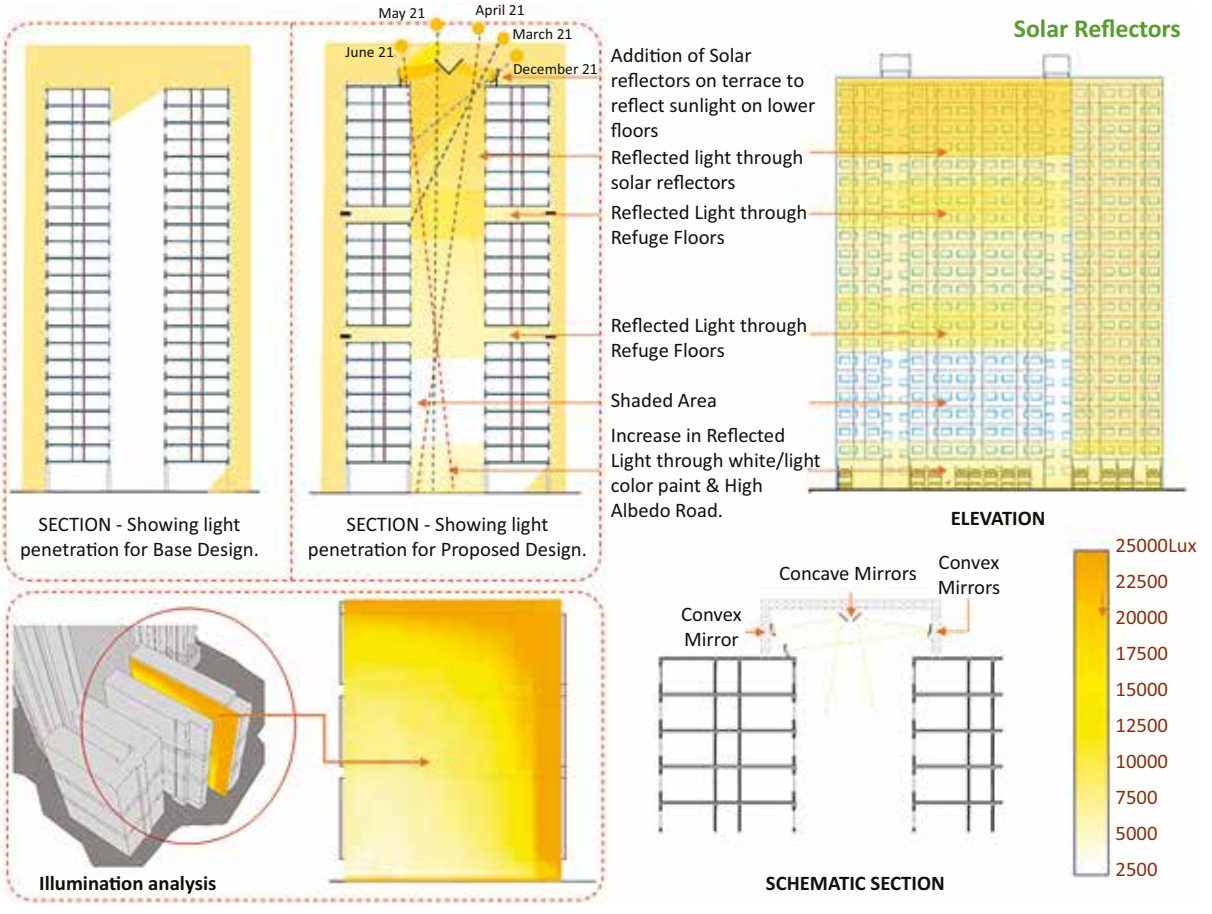
Grills for parapet: The provision of grills or punctured designs in place of solid handrails was found to be an effective alternative. The area of openings on the exterior surface or the surface facing the internal chowk increases due to the provision of grills. This allows better light to enter the building inner volume.

Through and through refuge: The refuge floor was mostly found to be open on one side only. By making the refuge floor through and through, the rate of wind flow can be improved. The wind flow was found to be more streamlined with an improved quality too (Figure 6).

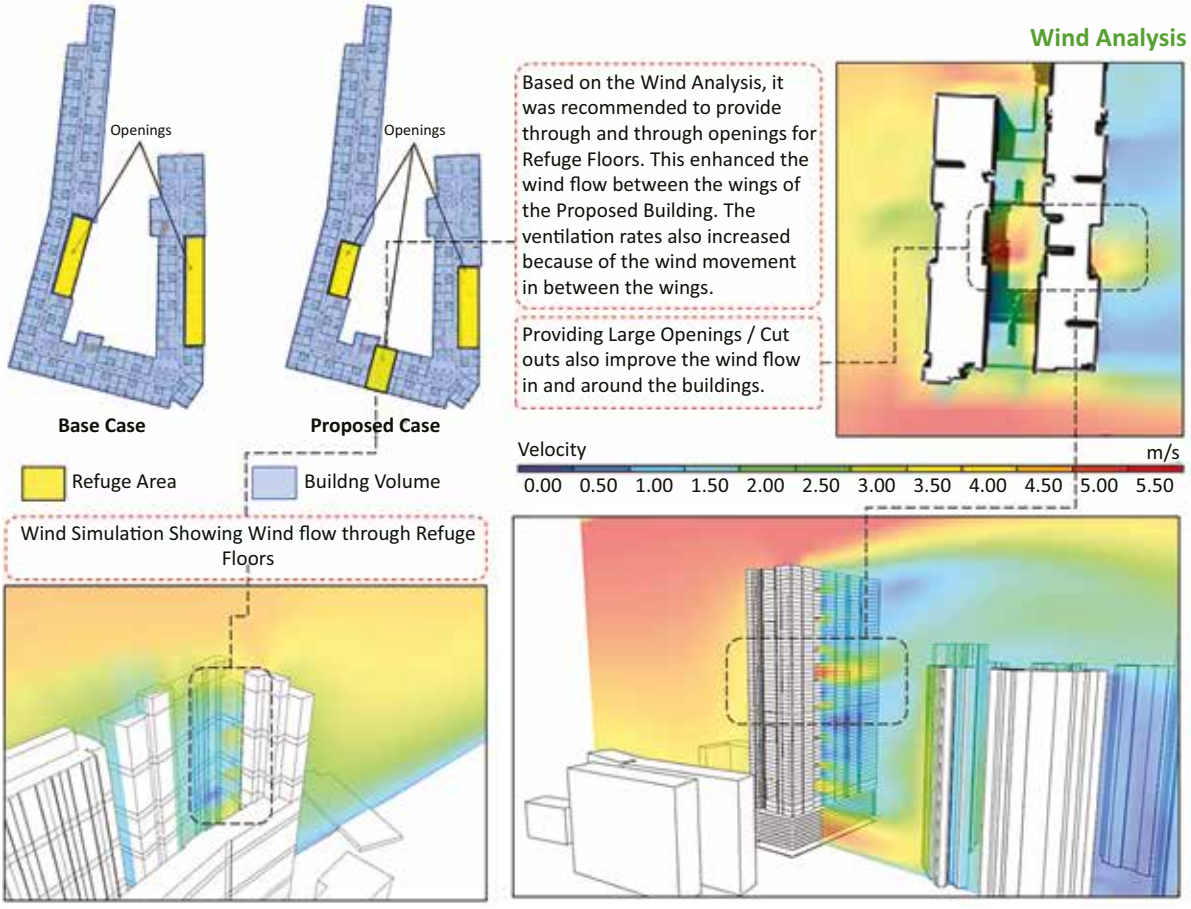
Large openings: Continuously packed buildings tend to obstruct the movement of the wind. There should be large openings in the building's volume to ensure proper wind flow in and around the buildings. This will streamline the wind flow (Figure 6) and create an opening for the air to flow inside the building evenly.

Conclusion

SRA buildings intend to serve the purpose of providing slum dwellers with housing and better living conditions. But in the current scenario, the quality of the SRA settlements needs reconsideration. The existing buildings, which are unable to meet the quality standards, should be revived with mitigation



» **Figure 5:** Solar reflectors between two closely packed towers



» **Figure 6:** Addition of through and through refuge floors and large openings in building volume

measures. This can be addressed only through a conscious and judicious design of such dwellings. More emphasis must be given to the provisions of lighting and ventilation by the architects to equip the SRA dwellings with better living conditions in the future.

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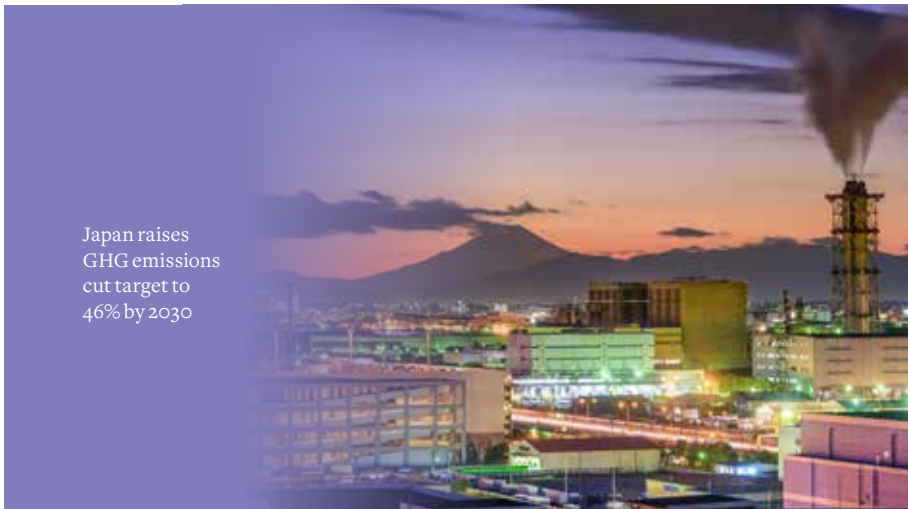

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Tripura Bamboo Mission

Restoring Green Economy of the State

In this article, **Ar. Atul Jayant Phoujdar** and **Ar. Arimita Roy Nag** discuss the objectives of the Tripura Bamboo Mission, which aims to restore the green economy by promoting bamboo plantation in the state. The mission promises to scale up the turnover of the bamboo sector and simultaneously improve the livelihood opportunities for the marginalized. This article is an effort to rekindle humanity's connection with nature.

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Ar. Arimita Roy Nag is an architect planner with 15 years' experience in various architectural and urban planning projects including teaching. She teaches at Thakur School of Architecture and Planning, Mumbai. As a research associate in CEPT University, she has worked on projects including CDPs and environmental mapping for different development authorities such as MMRDA and PKDA. She can be reached at tsap.arimita@gmail.com.

Introduction

Technological advancement, exploration of research in traditional techniques, and effective communication have taken human development beyond imagination. Despite reaching the peak of success, we are struggling to strike a balance in our lives. During the course of rapid development, we somewhere lost balance with nature, our ecosystem and environment. This is the reason that even after reaching a stage of triumph, we are still striving to go back to our roots.

Today, we are at the receiving end of global warming threats and natural disasters. As a result, we have disturbed our connection with nature for the sake of economic growth. However, it is never too late for honest efforts. This is the right time to renew our connection with nature.

> "Always remember your roots. They are the foundation of your life and the wings of your future."

With environmental sustainability as a key issue in the last few decades and climate change as a burning concern around the world, restoring the green economy is the need of the hour. A serious thought must be given to the green economy which touches upon efficient resource management, carbon control, and social inclusivity. Public and private investments govern income, economic growth, and employment. In this regard,

let us study the initiatives of the Tripura Bamboo Mission (TBM) to understand the need to be environmentally conscious.[1]

Tripura Bamboo Mission

Tripura is a state in Northeast India, which is situated on the foothills of the Himalayas. Due to the natural settings and climatic conditions, the state is blessed with 21 species of bamboo (Figure 1). In 2007, the state government took the initiative to restore the green economy by promoting bamboo plantation in the state. The objective of the mission was to scale up the turnover of the bamboo sector and simultaneously improve livelihood opportunities for the poor sections of society. Working on a sustainable module, socio-economic development could be achieved through a cluster approach involving institution building, technological linkage, and better market and credit facilities coupled with resource upgradation.

» Figure 1: Bamboo cultivation in Tripura, India

Initiatives of the Mission

Capacity building: More than 45,000 artisans have been trained by TBM on various aspects from bamboo plantation, production to marketing for generation of green jobs. TBM follows the National Skill Development Corporation model of skill training and gets continuous support from the Director of Skill Development, Government of Tripura.[2]

Institutional development: A strong institutional structure has been developed from the grassroots level with the help of artisans and producers. Around 1000 self-help groups, 60 producer societies/cooperatives, and community-owned institutions have been supported and promoted by TBM since 2007. Around 100 new bamboo farmer groups are added to the mission every year, and bamboo plantation activity is being promoted in new areas as well.

Common facility centres (CFCs): A total of 21 cluster CFCs have been set up in rural areas of the state. More than 50 small village-level units have been established, which are owned by the artisan community under various interventions by TBM.

Technology induction: New technologies have been introduced under this mission for treating bamboo dying, etc. Many machines have been imported, such as Japanese Juki machines, Taiwanese stick-making machines, power tools, semi-mechanized, mechanized *agarbatti* rolling, finishing machines, and semi-mechanized tools for bamboo stick-making.

Design and product development: Under the mission, an exclusive Design and Product Development Cell has been set up. Product designers and master artisans are teamed up to develop trendy and user-friendly craft ideas.[3] By partnering with eminent design institutes and designers, TBM has created a promising range of contemporary designs, especially in handicraft and furniture, which has resulted in a complete facelift of the products (Figure 2).

Private investment: A bamboo park is established for building resilient infrastructure for posterity. Investors from outside as well as

[3] Cane and Craft and Allied Industries. 2015. http://canecraftandalliedindustries.blogspot.com/2015/11/handicraft-of-tripura-masterpiece-of.html

» **Figure 2:** Bamboo handicraft products in Tripura

from within the state are also setting up technology-intensive bamboo industrial units, thereby creating green job opportunities for the locals in the state. Several other small-scale bamboo-based units have taken rented space inside the bamboo park developed by Tripura Industrial Development Corporation Limited.

Trade facilitation and market linkage: A Trade Facilitation Cell has been set up to establish market linkages under TBM. The cell helps promote investment in the green economy through a central supply chain between buyers and producers. One of the major steps taken include establishing marketing tie-ups with both national and international companies.

Bamboo plantation: Resource management is the backbone of any type of industry to generate economy in the state. Under TBM, bamboo plantation is undertaken by the forest departments. TBM implements bamboo plantation drives in private lands through a cluster development approach. TBM engages the bamboo growers and farmers in commercial bamboo plantations.[4] Till 2016, the mission implemented the plantation of around 1500 ha of commercially viable bamboo species across various rural development blocks of Tripura[5] (Figure 3). It has also promoted 10 women-run self-help groups for the creation of quality bamboo for commercial purposes.

Public Private Partnership Model

The PPP model adopted for TBM forms a strong and resilient backbone for the mission as the stakeholders involved are government bodies and tribal and rural communities. The mission is registered under the Societies Registration Act, 1860. The chief secretary, Government of Tripura heads TBM and the general body comprises secretaries and heads of departments of forests, handicrafts, industry, rural development, social welfare, tribal welfare, and others.

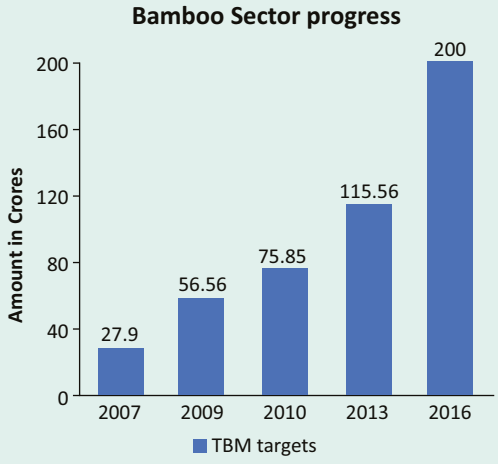
State Bamboo Policy

The vision of the State Bamboo Policy is to realize the economic, social, and environmental potential of the bamboo resources of Tripura. The aim is to develop bamboo into one of the major economic sectors of the state that would provide employment opportunities and income-generating activities to tribal communities and rural poor.

Benefits and

4 India TV News. 2014. Bamboo cultivation becomes rewarding for farmers in Tripura. https://www.indiatvnews.com/news/india/bamboo-cultivation-becomes-rewarding-for-farmers-in-tripura-45198.html

5 For more details, visit https://industries.tripura.gov.in/bamboo



» Figure 3: Year-wise targets of Tripura Bamboo Mission (Source: Tripura Bamboo Mission)

Conclusion

As a catalyst, TBM pushed the turnover of the bamboo sector to hit a five-fold increase in the last nine years. The mission is a fine example of restoring the green economy in the state and can be adopted in other states too by identifying the potential and strength of that particular region or state. Initiatives like TBM have a lot of character and calibre to strengthen the socio-economic fabric. Such modules are competent and executable to give the desired direction to generate a green economy as well as ensure social inclusivity while maintaining environmental consciousness. And over time, additional benefits such as decarbonization, local training, and awareness can certainly make promising changes in the green sector.

Potential

TBM brings along with it a set of benefits and potentials which can be taken as a module in various regions having similar geographical and environmental conditions. Such modules can inspire several other sectors interested in developing a green economy through an environmental approach aided by local involvement and sustainable tactics. A few of these benefits and potentials are explained in Tables 1 and 2.

Table 2: Potential of TBM

Potential of the Mission Bamboo Initiative			
Promotion of small-scale industry	**Exposure to international market**	**Platform to display awareness**	**Tourism opportunities**
Demonstrate importance of small-scale industries Get maximum benefits Policy creations or adoptions for small-scale industry	Attract international investors Environmentally rewarding at larger scale Online small industries can have noticeable role in international market	Ideas should reach maximum population so that environmental strategies are capitalized Government policies can provide appropriate platforms	Innovation in product design and efficient exposure can develop tourist attraction Ensure awareness among young students and professionals Promote environmental consciousness

Table 1: Benefits of TBM

Benefits of the Mission Bamboo Initiative			
Environmental benefits	**Decarbonization benefits**	**Socio-economic benefits**	**Local green job opportunities**
Replace many man-made hazardous materials, keep environmental balance Tested and verified material for complicated designs Generate environmental awareness	Restrict carbon content in atmosphere Maintain ecological balance Promote environment-conscious practices in day-to-day life	Encourage social involvement and training opportunities Develop knowledge base for innovative production Involve locals in economy generation	Ensure non-dependency on technology or advanced expertise Create job opportunities at local level Train and make locals aware of green growth

Systems Approach to Goal-Setting for Sustainability in Building Design

Lavanya P. Arun believes strongly in the impact of public policy in sustainable development. Her work at Smarter Dharma revolves around influencing public discourse and guiding public policy to strengthen institutional frameworks to foster and protect social and environmental sustainability. Her approach to work is data-driven and bolstered by evidence-based research. She started her career in a consulting firm, specializing in macroeconomics and analytics. She then wanted to be on the other side of consulting and on the field, so she moved to a wind turbine manufacturing company and worked as a strategist. She also has experience in writing discussion papers commissioned by the MoEF on policy issues.

She has a Master's degree in Economics, and is a UN volunteer who teaches ESL in her spare time.

How sustainable is the process of designing a building? What is the role of a stakeholder in the design ecosystem? In this article, **Lavanya P Arun** addresses these questions while highlighting the principles of green architecture that aims to realize the goals of environmental sustainability, economic sustainability, and social sustainability.

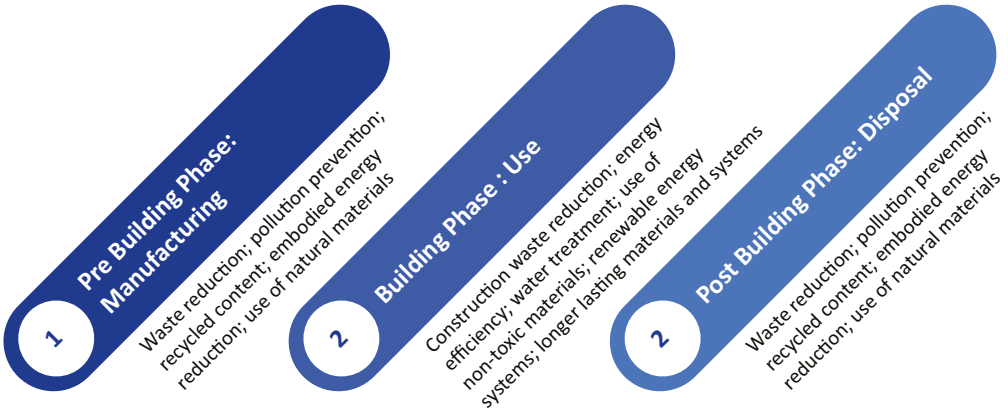
Sustainability as the Common Goal

It is common knowledge that several stakeholders are involved in designing a building. The builder, architect, and the buyer are at the core of the design ecosystem; experts and specialists such as green consultants, certification consultants, energy experts, and material experts are brought on board to fulfil specific requirements based on needs such as certifications, net zero goals, low-cost architecture, and so on.

The question is, 'Do the stakeholders work together towards a common goal?' Not quite. This system essentially follows a linear workflow. A design is first created by the architect, prioritizing either comfort, aesthetics, economics or efficiency. The other stakeholders are then forced to tweak their interventions around that design. So, the other considerations become mere add-ons and are not integral to the design process. This paradigm leads to the sub-optimal utilization of available resources as it is predisposed to the various professionals working in silos, and therefore, it does not lend itself to common goal-setting. This limits the possibilities that can be achieved through a synergistic approach (Figure 1).

Systems Approach for a Holistic View of Challenges

To illustrate this point, we will look at an example of fenestration design. If we consider the fenestration design of a building, an architect while designing the fenestration would primarily base it on the building orientation and required ventilation. And if energy efficiency is a priority, the architect will give most attention to the building envelope design. The



» **Figure 1:** Holistic approach to challenges

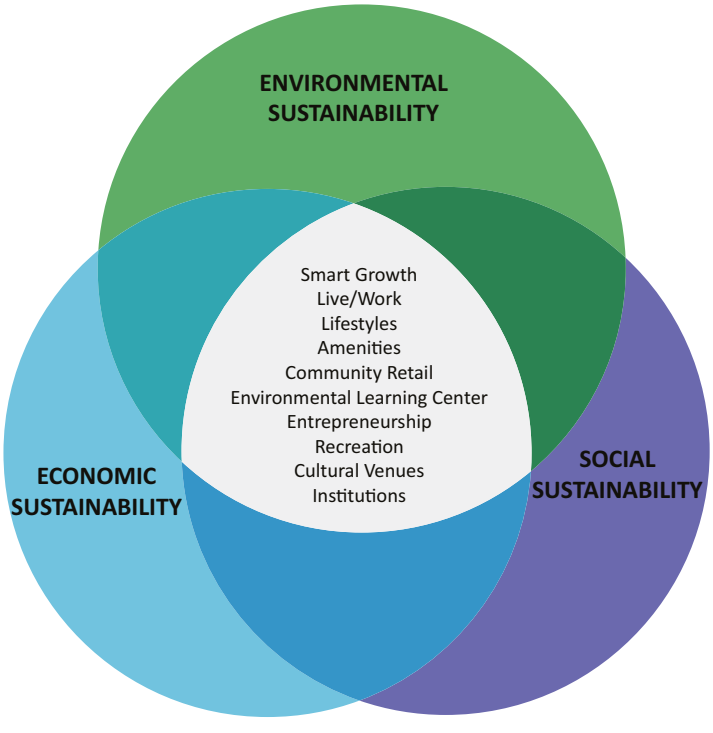
recommendations of green building certification programmes would also place the focus on the reduction of solar radiation and use of shading devices among other factors.

Apart from these considerations, some of which are basic and others specialized, there are more inputs that go into the process of designing a building. For instance, the embodied carbon in building materials can be taken into account, the Life Cycle Analysis (LCA) of the materials used can also weigh in as a determinant. Accordingly, the decision-making process will then include variables such as the following:

- The location of manufacturing products with more weightage given to sourcing from within the radius prescribed in the environmental analysis tool;
- Volatile Organic Compound (VOC) limits in adhesives and paints;
- Fabrication techniques to reduce waste;
- Higher percentage of recycled content;
- Efficiencies to reduce or eliminate on-site waste of resources.

These attributes are not considered otherwise. The inclusion of these criteria does not in any way have to compromise on the other considerations. But to transition to this new holistic paradigm, a systems approach is essential. With the technical prowess available today, it is possible to bring information and empirical evidence to one place and enable holistic planning and comprehensive goal-setting for projects.

In the absence of such a system, interventions are at best trade-offs between different priorities. Knowledge and computing have to come together to eliminate sub-optimal trade-offs. An energy-efficient intervention need not fulfil just one goal. It could, for instance, also rank low on embodied carbon and high on recyclability, thereby fulfilling three



» **Figure 2:** Circle of sustainability

» **Figure 3:** SDG mapping of sustainable construction (***Source:*** *World Building Council*)

essential goals (Figure 2). The lack of an integrated approach to design leaves such solutions unexplored. A data-driven systems approach enables optimizing solutions.

Systems Approach to Goal-Setting at Macro Level

At a macro level, integration and comprehensive goal-setting by multilateral organizations and governments are imperative to ensure the success of the global agenda, such as the Sustainable Development Goals (SDGs). Efforts in myriad directions to fulfil different SDGs could work to undermine each other without an integrated approach that directs efforts to create synergies.

For instance, according to the Intergovernmental Panel on Climate Change (IPCC), 2018 report – *Summary for Policymakers* – providing access to safe drinking water (target 6.1), and enabling income growth (target 10.1) will bolster efforts to eradicate poverty (target 1.1) (Masson-Delmotte, Zhai, Roberts, *et al*. 2018). Another study by Krey, Riahi, and McCollum (2011) showed how simultaneously targeting energy security (SDG 7), climate change (SDG 13), and air pollution (linked to multiple goals) in energy systems could improve all three at a slightly higher cost than achieving only the climate change goal (Figure 3) (McCollum, Krey, Riahi, *et al*. 2013).

Be it project planning at the micro level or setting a global agenda at the macro level, organizations have to shed their myopic nature and become more integrated and synergistic. Systems that leverage the present technical feasibility and bring together all stakeholders and interventions to one place enabling comprehensive goal-setting must be adopted to offer meaningful and lasting solutions.

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Designing COVID-Resilient Homes

In this thought-provoking article, **Dr Jatinder Kaur** highlights the importance of designing homes that are resilient to not just natural disasters but can also resist and withstand outbreaks such as the ongoing COVID-19 pandemic. She urges the fraternity of architects to draw inspiration from our past on how to develop coping mechanisms to stand tall against epidemics and pandemics.

Dr Jatinder Kaur, a PhD from IKG–PTU, Kapurthala has 25 years of experience in teaching and research. In her current role as Associate Professor in Architecture at SPA, New Delhi, she is engaged in art, poetry, and academic writing. She is a recipient of two IPRs in the form of a copyright and design registration for her PhD work. She can be reached at jatinderkaur@spa.ac.in.

In 2020, the COVID-19 pandemic dropped like a bomb and opened up a Pandora's box of challenges and hurdles for the world, as nations witnessed the spread of the coronavirus in utter stupefaction. Since then, the virus has been moving with fluidity and penetrating deep into the developing and developed countries without any bias or mercy. While humankind was trying to unlearn the concepts of "socializing" and learn the new COVID-19-appropriate behaviour and norms of "social distancing", the imposition of nationwide lockdowns came down as the seemingly only available option for containing the spread of the outbreak. Our homes became lifesaving places of solace in the thick fog of uncertainty.

The *Oxford Dictionary* defines a "home" as "the house, apartment, etc., where one lives, especially with family" (Oxford n.d.). However, the notion of a home, which is generally understood to provide a "space for living", expanded to a "living laboratory" where the COVID-19 outbreak and erratic lockdowns acted as contaminants in the interaction between spaces and inhabitants. The outcome of these interactions were new experiences and meanings when personal and professional needs overlapped with each other, and family members struggled to find a corner of their own in confinement. Though the "home" was performing the basic function of providing shelter to its inhabitants including pets during the pandemic, its meaning altered drastically over a time period of one and a half

years (Düzen and Ekrem 2021). Its transcendence from being merely a "shelter" to a "home", supposed to meet expectations of inhabitants of varied age groups, and rendering meaningful spaces to all, raised doubts on the suitability of its spatial articulations.

Bruno Zevi summarizes the real essence of "meaning" and says, "Architects intend meaning for what they design; but users attribute meaning to what they experience". Therefore, the design of a home should essentially respond to the needs of its users, and be a clear statement of their way of life such that they become a "part of home" rather than being just "inside home". The pandemic brought with it the law of inversion which rendered large public places into unused hollows, begging for more open spaces and ventilation facilities in the safe confines and privacy of our own homes. It also raised questions on the common attributes of a home which were earlier limited to the sense of belongingness, desire, and privacy, and were now oppressed with feelings of fear, anxiety, and alienation. Home, thus, became a place of introspection, contemplation, and recapitulation. Many "What ifs" and "Whys" hovered over the home with the following questions on everyone's mind:

- What if a family member unknowingly brings the virus home and all fall sick?
- What if there is/are not sufficient space(s) to isolate all family members?
- Why isn't there sufficient space between the entry and habitable areas that can be used as sanitization buffer?
- Why are verandas/balconies so minimalistic in comparison to covered areas, and those too are turned into storage spaces rather than being equipped for sitting?
- Why was an air conditioner installed in the window, which could otherwise have been opened to let fresh air in?

Amidst these brooding queries, the usual functions of spaces had to be manipulated to suit the shuttling roles of being a "professional" during working hours and returning to the "personal" space thereafter. Consequently, the related experiences and meanings also altered. The entrance doorway which once welcomed our near and dear ones became a point of intervention and interruption. It also transformed into a zone for sanitization and hanging masks. The living room, usually reserved for guests, was now thronged by children for attending online classes, parents for online meetings, and the elderly to simply walk around. Bedrooms became virtual offices and classrooms, while kitchens morphed into quarantine areas as and when required. The dining room lost its predominant meaning of sitting and having meals together, instead, it became multifunctional and got converted to a workstation or even a play area for kids (Jyoti 2021). Open spaces – verandas/balconies – which were mostly designed to meet the norms of building codes, became the only spaces for "safe social interaction". Those who were not fortunate enough to have such open spaces reached out to the windows to soak in the much-needed visual

connect with the outside world. Common spaces such as corridors, stairs, and lifts emerged as areas which communicated meanings of apprehension, anxiety, and discernment.

As this dilemma of inversion begins to deepen further and the "new normal" shape-shifts to become the "ideal normal", there is an urgent need to revisit the three elements of architecture, i.e., *firmitas* (durability), *utilitas* (utility), and *venustas* (beauty) given by the 16th-century Venetian architect Vitruvius. In a tryst to provide meaningful experiences to the inhabitants, the aspect of "utility" leaps ahead of "durability" and "beauty".

This perspective is also univocally stated by Gerald Adler and Gordana Fontana-Giusti, who believe that architecture develops and responds to user-specific needs. They further mention that buildings definitely get impacted by any natural or man-made crisis (Wood 2021). Health crisis in the form of pandemics is also not new, since prior to the COVID-19, the world had witnessed deadly and perhaps more infectious outbreaks, such as the Antonine plague (165–180 AD), Bubonic plague (1347–1351), Smallpox (1520), Cholera-6 (1817–1923), Spanish flu (1918–1919), and Ebola (2014–2016) to name a few (LePan 2020).

It is evident that the factors of health, safety, and architectural design have been at the points of intersection in the past too. Architecture has been known to acknowledge and accept changes in response to challenges as witnessed in the period of modern architecture. Design features such as closets, powder rooms, and ceramic tiles were outcomes of thoughts put together in the aftermath of the Spanish flu, tuberculosis, and cholera (Yuko 2020). Le Corbusier's Villa Savoye (1928) had a handbasin in the entrance hall, which met raised eyebrows at that time. But its inclusion in the architectural design came as an after-effect of the devastation caused by the Spanish flu, and it eventually became a norm for maintaining hygiene. Even the psychological effects of colours were explored to communicate meanings of sterility, purity, cleanliness, and happiness in hospitals. Sunlight and fresh air were harnessed inside the buildings to offer adequate defence against tuberculosis and flu (Philcox 2020). However, the concepts of having "sleeping porches" in Victorian houses, which could be used as resting outdoor spaces in times of normalcy, and adapted for providing

fresh air to cure people suffering from tuberculosis, lost continuity in the later architectural expressions. Similarly, villages of Saranac Lake, New York had "cure cottages" designed as flexible spaces to be transformed into isolation facilities when required (Philcox 2020).

The COVID-19 pandemic has once again compelled architects to put on their thinking caps and evaluate spaces which were thought to be appropriate so far. It is time to reconstruct the spatial autonomy of a home in a post-COVID era. Spatial designs must be multifunctional for multiple users and have abilities to perform as an office, a school, a gym, an entertainment area, a meditation area, a quarantine facility, and much more depending upon user-specific needs, but without compromising on the physical and mental health safety. The norms of having spaces for sanitization at entry point(s), adaptability of spaces to be turned into sections of isolation, adequate provision of open spaces, maximum light, and ventilation could be considered for exploration. But the conversation must start with the mapping of experiences of those who faced inconveniences and deprivation in their homes during lockdown (LePan 2020). Some pertinent questions to ponder on and resolve through design are as under:

- How has the COVID-19 altered the meaning of a home and its purpose?
- How can the design of a home resonate with the experiences and new expectations of users?
- How can spatial configurations of a home help in the healing process?

The approach of including users and the community as a whole in the design process can also help achieve the global Sustainable Development Goals (SDGs), in which SDG 11 emphasizes to "Make cities and human settlements inclusive, safe, resilient, and sustainable". The journey towards inclusivity, safety, resilience, and sustainability must commence from homes, where experiences and expectations of users can give succour and ameliorations for accomplishment of the previously discussed goals. Newer possibilities in designs can pave the way for a future where a home would be conceptualized as the lifeline of a family apart from being an extension of the infrastructure in the larger perspective. The notion of a "home" needs to be taken from being "responsible for accommodating users" to "response-able", i.e., having an ability to adapt to change of any kind. This phase of evolving dynamics should not be mistaken for its temporariness, rather be taken to "reassess", "redefine", and "reanalyse" the spatial autonomies of homes in order to be future-ready in a way that these spaces become places to "unwind", "relax", and "recharge".

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Sustainable Urbanscape and Growing Relevance of Green Infrastructure

In this article, Dr Pranab J Patar foregrounds the relevance of green infrastructure (GI) in urban centres of the Indian subcontinent. With climate change risks, global warming threats, and unsustainable practices in an age of globalization, the utility of GI has assumed a new meaning altogether. Our ecosystem is in danger; disappearing waterbodies and diminishing green spaces are serious threats we must address immediately. In this regard, GI is the only solution that must be adopted soonest, the author argues in this timely piece.

» **Figure 1:** Urban Green Space, Noida

Today, the disappearance of green and blue spaces is a major cause of concern for both rural and urban areas. For most urban centres, the crisis is more pronounced given the increasing anthropogenic pressure in the cities and towns (Figure 1). The way things are in the so-called developed spaces, industrial expansion and concretization have taken over a large part of natural and open spaces leaving very little for the non-human urban dwellers.

The fallout is already evident in terms of increased waterlogging, groundwater shortage (due to lack of aquifer recharge), increasing urban heat island effects, and micro-climatic changes to name a few, the occurrences of which are becoming frequent in most urban centres with each passing day. By destroying these natural areas, we are letting our guard down against climate change risks.

Though the term 'green infrastructure' (GI) might sound alien to many, waterbodies and green areas are common features in most cityscapes. As per historical evidence, the evolution of GI in the Indian subcontinent started around as early as 3000 BC during the Indus Valley Civilization. Gradually, several other cities/building complexes established around the period

Dr Pranab J Patar is an award-winning environment and sustainability professional. Currently, he is Chief Executive of Global Foundation for Advancement of Environment – a Delhi-based Indo-American initiative – where he leads a number of initiatives towards finding innovative and enduring solutions to some of the key socio-environmental challenges through multi-stakeholder, trans-disciplinary, and hands-on approaches. He can be reached at pranab.patar@gmail.com.

» **Figure 2:** ESCI Lake Hyderabad

» **Figure 3:** Urban Blue Space, Hyderabad

1500–1800, such as Jaipur, Udaipur, Bengaluru, and New Delhi exhibited GI solutions, including structured water management and conservation system.[1]

It is a different debate altogether whether the sense of responsibility to incorporate these sustainable features is somehow fading away with time or, are we becoming way too engrossed in a materialistic lifestyle? Nonetheless, as a society, we haven't become completely indifferent towards ecosystems that are synonymous to our existence.

While there are various definitions of GI, the European Commission describes it as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings.[2]

GI encompasses both green and blues spaces that make a vital life support system, which is a network of interconnected and isolated ponds, lakes, wetlands, green corridor/belt, city parks, lush green campuses of educational institutes, private and government agencies in the urban context (Figures 2 and 3).

A country like India, which is a designated mega-diverse nation and is home to a large number of ecosystems including forests and waterbodies of various shapes and sizes, both flowing and stagnant, currently faces the worst-ever water crisis in its history. In terms of surface waterbodies, India is among the top countries that holds maximum amount of freshwater. According to a report by FAO, India finds itself in the list of top 10 water-rich nations.[3] However, the irony is, India also appears in another list of most water-stressed countries prepared by World Resources Institute,[4] and is the only country from the FAO list to have found a place in the other list.

Today, both the quality and quantity of water are equally compromised. On the one hand, our lakes, ponds, and wetlands are disappearing at a faster rate than one can imagine, and on the other hand, increased pollution levels have crippled the remnant sources of freshwater (Figure 4). It's a double whammy for India's stock of renewable water resources. Recent reports of disappearing waterbodies and diminishing green spaces from every notable urban centre are alarming. With an ever-increasing population and its rising needs, it is very likely that we will soon outgrow the environmental threshold of every urban centre.

At the beginning of the 20th century, India's urban population was only 25.85 million which rose to 285.35 million by 2001, and in 2011, it jumped to 377 million.[5] Today, about 55% of

1 Rohilla, S.K., S. Jainer, and M. Matto. 2017. *Green Infrastructure: A Practitioner's Guide*. New Delhi: Centre for Science and Environment. Details available at http://cdn.cseindia.org/attachments/0.91656700_1505301183_Green-Infrastructure-guide.pdf

2 interreg-central.eu. n.d. 'Green Infrastructure Definitions.' Details available at https://www.interreg-central.eu/Content.Node/Definitions.html

3 FAO (Food and Agriculture Organization). n.d. 'World Water Resources By Country.' Details available at http://www.fao.org/3/y4473e/y4473e08.htm

4 Hofste, R.W., P. Reig, and L. Schleifer. 2019. '17 Countries, Home to One-Quarter of the World's Population, Face Extremely High Water Stress.' World Resources Institute. Details available at https://www.wri.org/insights/17-countries-home-one-quarter-worlds-population-face-extremely-high-water-stress

5 Bhakar, P. 2012. Urbanization and changing green spaces in Indian cities (Case study

the world's population – 4.2 billion inhabitants – lives in cities and given the existing pace and trend, by 2050, it is predicted that urban population will become twice its current size with nearly 7 out of 10 people in the world living in cities.[6]

Presently, cities are struggling to handle the increasing population load and the related demands for goods and services. If this is to continue unabated, soon, we will be facing serious socio-economic, political, and cultural ramifications due to lack of water resources and forest cover (Figure 5). The early signs are already visible in the form of shortage of drinking water, internal water conflicts, erosion and landslides, increased waterborne diseases, crop failure, urban flash floods, soil pollution, depleting air quality induced by water pollution, and so on.

The damage caused in terms of loss of ecosystem services is beyond comprehension – waterbodies and green cover are home to a variety of flora and fauna; they are the most potent carbon sinks and our best bet to build climate resilience. The recreational, educational, and health benefits that the communities reap from the blue and green spaces are numerous, and in the cultural context too, waterbodies are integral to many festivals and religious practices celebrated and observed in India.

The economic losses arising from the depletion of green cover and waterbodies can hit us severely.

– city of Pune). *International Journal of Geology, Earth and Environmental Sciences* 2(2):148–156

[6] World Bank. 2020. 'Urban Development: Overview.' Details available at https://www.worldbank.org/en/topic/urbandevelopment/overview

» **Figure 4:** Shrinking Urban Freshwater Body, Ghitorni, Delhi

Besides destroying the only source of livelihood for many, such a crisis can further dampen the already struggling tourism industry owing to the ongoing COVID-19 pandemic.

This aggravating situation calls for both new interventions and reinforcements to support the failing GI. Cities and towns are considered the epicentre of economic activities, technological advancements, innovations, investments, and employments,[7] and if our urban centres are to continue with these sought-after offerings, we will have to, rather quickly, build a shield of GI around us.

With the Smart Cities Programme running in full swing, there's a scope and an opportunity to integrate sustainability factors more holistically into city planning. Mainstreaming environmental consideration in developmental projects is the need of the hour; by conserving, developing (even constructing), and restoring the green cover and waterbodies, including constructed wetlands (Figure 6), we can pave the way for creation of greater dividend socially,

[7] Mukherjee, M. 2013. 'Urban India: Challenges for Green Infrastructure.' For Central Europe towards Sustainable Building. Details available at http://www.cesb.cz/cesb13/proceedings/8_infrastructure/CESB13_1222.pdf

» **Figure 5:** Disappearing City Forests, Vasant Kunj, Delhi

environmentally, and economically. It is reasonable to believe that cities can only become smart when they are sustainable too.

While there are several tangible benefits of having blue and green spaces, these areas are vital for the health and well-being of local communities. With indoor recreational facilities including gym/swimming pools being shut for a long time to contain the spread of the coronavirus, communities across many countries used urban spaces for (while maintaining social distancing norms) activities such as hiking, biking, camping, fishing, birdwatching, and nature walks.[8] Additionally, while the COVID-19 pandemic has left many mentally disturbed by its overwhelming impact on life and livelihood, these spaces helped us find solace, calm, and tranquillity.

Recently, India announced a funding of INR 60 billion (about US$ 790 million) under the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) to generate employment opportunities through afforestation and forest restoration activities in urban, semi-urban, and rural areas.[8] Initiatives such as this will only enhance our ability to fight the adverse effects of climate change and create further scope for economic growth through investments, environmental entrepreneurship development, and green job creation.

Western countries consider GI to be a major contributor to GVA (gross value added), which manifests through improvements to a region's image, helping to attract and hold high-value industry, entrepreneurs, and workers. For instance, in 2008, the northwest region of the UK supported 109,000 jobs worth £2.6 billion in GVA through GI.

GI seems to have been creating both tangible and intangible values that increase the scope for leveraging private sector investment, thereby minimizing unemployment risks and increasing GVA.[9] Several cities of the world such as, Singapore, Stockholm, Boston, and Vancouver have invested successfully towards GI development by engaging in GI-related activities.

By promoting the application of GI in cities, the decentralized conservation approach too can be strengthened because there is a need to shift the focus of conservation activities outside the protected area network to conserve biodiversity wherever they are even at a micro level. Now, with the emergence of the OECM (Other Effective (area-based) Conservation Measures) concept, which was adopted during the 14th Conference of Parties of the Convention on Biological Diversity in 2018,[10],[11] the values of ecologically important areas/green pockets towards achieving positive and sustained long-term outcomes for the in-situ conservation of biodiversity have become even more critical.

» **Figure 6:** Constructed Wetland, East Delhi

The idea of GI can be promoted as a sure-shot formula to bring ease to overused and over-stressed urban spaces besides improving ecosystem services provision – a benefit that has been proven in multiple research-backed studies.[12]

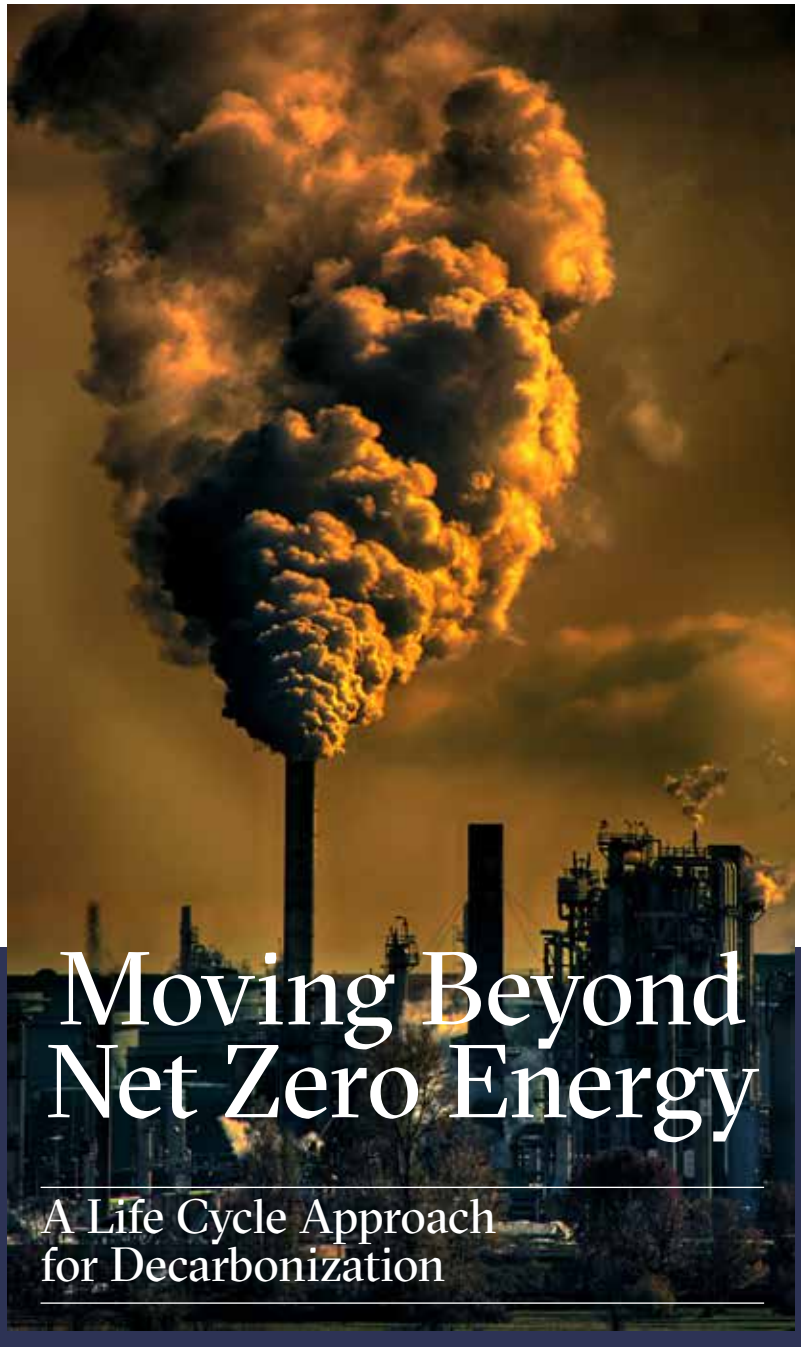
[8] UN (United Nations). 2020. 'UN/DESA Policy Brief #80: Forests at the heart of a green recovery from the COVID-19 pandemic.' Details available at https://www.un.org/development/desa/dpad/publication/un-desa-policy-brief-80-forests-at-the-heart-of-a-green-recovery-from-the-covid-19-pandemic/

[9] NS+ 2008. 'The Economic Value of Green Infrastructure.' Details available at http://www.greeninfrastructurenw.co.uk/resources/The_Economic_Value_of_Green_Infrastructure.pdf

[10] Biodiversity Information System for Europe. n.d. Other effective area-based conservation measures. Details available at https://biodiversity.europa.eu/protected-areas/other-effective-area-based-conservation-measures

[11] IUCN (International Union for Conservation of Nature). n.d. World Commission on Protected Areas. Details available at https://www.iucn.org/commissions/world-commission-protected-areas/our-work/oecms

[12] Teodoro, S., R. Aretano, and A. Pomes. 2017. 'Green Infrastructure to Improve Ecosystem Services in the Landscape Urban Regeneration;' IOP Conf. Series: Materials Science and Engineering:245. Details available at https://www.researchgate.net/publication/320859980_Green_Infrastructure_to_Improve_Ecosystem_Services_in_the_Landscape_Urban_Regeneration



Moving Beyond Net Zero Energy

A Life Cycle Approach for Decarbonization

Mindfulness is the need of the hour in the construction industry. Considering India's current energy mix and rate of emissions, **Mili Jain** in this stimulating piece foregrounds the urgent need to concentrate on life cycle analysis and carbon quantification to simplify the road to net zero carbon.

Mili Jain is an architect and building energy professional with expertise in LCA and carbon footprint. She has worked on the quantification of the cradle-to-cradle carbon footprint of existing buildings to be able to formulate carbon offset plans. Trained at SPA Delhi and CEPT University, she founded Monk Spaces with the belief that both people and buildings can benefit from a little more mindfulness. She can be reached at mili@monkspaces.com.

In 2019, India emitted more than 2300 Mt of CO_2 and our country's rate of emissions per capita continues to grow despite the ongoing COVID-19 pandemic (IEA 2020). USA and China have avowed net zero carbon emissions by 2050 and 2060, respectively. As the third highest emitter of negative CO_2, India's plans on climate action need to be urgently assessed. It is commonly known that building operations account for almost 30% of global carbon emissions. It is a lesser known fact that another 10% is generated from construction-related industries (UNEP 2020).

A net zero status is popularly understood as the gold standard in building energy efficiency. In typical situations, a building achieves this status based on an annual balance sheet of electricity. This balance sheet presents an environmental evaluation for the building, annually, in terms of its Energy Performance Index (EPI). The key performance indicator is the annual consumption (EPI) with respect to the on-site generation (net-EPI). It is typically measured in kilowatt-hour (kWh) and expressed as a function of the building area (kWh/m^2/yr). The common use of this metric is based on the idea that annual savings in electricity translate to reduction in greenhouse gas (GHG) emissions. However, recent research has suggested that may not be the case (Bordass 2020).

A net zero status is achieved through the provision of elements such as insulation, high-performance glazing, on-site photovoltaics, etc. The provision of these systems increases in embodied emissions of the building (Adams, Burrows, and Richardson 2019; Graham 2019; Schmidt, Crawford, and Warren-myers 2020). The annual performance evaluations do not consider the embodied carbon released before the use of the building. With these additional provisions, the embodied emissions of a net zero building can be higher than those of a typical building. The annual savings may or may not be able to compensate for these additional emissions, even across the lifespan of the building. For the building industry, a positive net-EPI is not good enough to ensure a significant reduction in emissions anymore. It is now necessary to be able to quantify the total impact of a building on the environment across its life cycle.

The total impact can be quantified through a life cycle analysis (LCA). When typically conducted for economic costs, an LCCA (life cycle cost analysis) not only considers the annual net sum but also looks at initial investments, inflation, depreciation, and residual costs. Similarly, a life cycle carbon analysis needs to include upfront carbon, annual emissions, and end-of-life processes. An LCA for a building requires the use of a metric that applies to all the phases of a building's lifespan. This metric must account for GHG emissions,[1] typically measured in terms of equivalent carbon dioxide (CO_2e). The metric should quantify the emissions from various GHGs based on their global warming potential (GWP). Once the impact is quantified in terms of CO2e, it can be normalized for the factors of time, area, occupants, and cost. This normalized value can be used for comparative studies or benchmarking (*Parkin, Herrera, and Coley 2020; Ürge-Vorsatz, Khosla, Bernhardt, et al. 2020*).

Embodied carbon is projected to account for 50% of the total carbon footprint of new construction until 2050 (Adams, Burrows, and Richardson 2019). Data on embodied carbon can be sourced from life cycle databases and environmental product declarations (EPDs) based on their applicability to the project's geography and time. Contextualizing the data sets for each project is necessary to come close to the true impact. The share of these emissions in the total life of a building can vary so much that it is not feasible to draw a simple, broadly valid conclusion. The variations in these shares are primarily due to differences in construction materials and technologies.

[1] GHG emissions in buildings are typically indirect, occurring due to the use of electricity in the building. Absolute emission numbers, therefore, largely depend on emission factors considered during calculation (Lucon, Ürge-Vorsatz, Ahmed, et al. 2014). There is a need to include gases other than CO_2 because some construction products and HVAC equipment emit substantial amounts of GHGs, such as methane, nitrous oxides, and HFCs.

The handling processes at the end of a building's lifespan have multiple options as well. The building may be demolished as an entity or consciously dismantled for reuse or recycling. While metals, wood, glass, and plastics may be extracted for reuse and recycling, debris consisting of concrete, bricks, and tiles are typically landfilled. Only a handful of cities in India, like Ahmedabad, have a construction and demolition (C&D) waste recycling facility. The emissions generated due to the use of such a facility are rarely included in the environmental impact assessment (EIA) of the building. However, a cradle-to-cradle analysis necessitates the inclusion of these emissions.

The recent LCA studies in India have dealt with the handloom industry, waste management options, rooftop solar PV systems, and so on. LCA studies for buildings have been sparse and mostly based on foreign data sources. This is because LCA is both data-intensive and data-sensitive. A methodology for carbon quantification is in place. It is only a matter of finding and using the right data sets. The quantification of carbon leads to the possibility of compensation through carbon offsets.

While offsetting carbon is environmentally crucial, it is important to understand the economic cost it entails. This is because the cost and benefits of an absolute zero carbon building accrue to different stakeholders during different phases of the building's lifespan. Many of these financial benefits do not go to the developers and constructors, but to the occupants, thereby creating a split incentive. Consequently, a high upfront cost is one of the biggest roadblocks for policymakers trying to increase performance requirements while maintaining the viability of the policy (Graham 2019).

It must be noted that the calculation of the required offset, with no regard to the costs it comes at would be a study in isolation. This incremental cost for carbon offsetting also needs to be put in perspective to the actual cost of the building. For instance, a study conducted by the UK Green Building Council in early 2020 explores the replacement of material to compensate for embodied and operational carbon. The cost analysis reports that the incremental cost for an office building was only 6%. These costs were reported to be relatively marginal and expected to be recouped through associated increases in rental and capital value (UK GBC 2020).

Life cycle analysis and carbon quantification can simplify the road to net zero carbon. Considering our rate of emissions, absolute zero carbon should be the ideal target. However, with current building technologies, achieving that seems impossible. In our existing situation, net zero carbon needs to be the intermediary target. This target will also open up explorations on circularity in design and alternative materials.

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IN THE SPOTLIGHT

April 23, 2021

China will start phasing down coal, starting in 2026, as part of its climate commitments, President Xi Jinping said at a summit of global leaders. US-Chinese cooperation on climate was also promoted, but the lukewarm agenda disappointed some scientists and activists

July 7, 2021

The Ministries of Environment, and Tribal Affairs have jointly issued a circular to chief secretaries of all states, giving the responsibility of implementing the Forest Rights Act, 2006 to state governments

June 22, 2021

Centre's NIOT to monitor sand mining in intertidal regions of A&N Islands

June 2019 – January 2020

The Australian bushfire season ending in early 2020 was a record-breaker, having burned more than 46 million acres and destroyed more than 3500 homes

June 2021 – July 2021

An extreme heatwave affected much of Western North America, which was linked to the effects of climate change. Over 800 people were estimated to have died due to the excessive heat

May 2020

Floods and Cyclone Amphan in India accounted for maximum loss of lives globally due to climate change-triggered events in 2020. The cyclone led to "the biggest displacement" in the world in 2020 caused by a natural calamity

GREEN SWANS OBSERVATORY

JOHN ELKINGTON

John Elkington, Founder and Chief Pollinator at Volans is one of the founders of the global sustainability movement, an experienced advisor to business, and a regarded keynote speaker and contributor. He tackles some of the world's most challenging problems, helping key actors move from the responsibility agenda through resilience to regeneration. He has inspired a number of Volans' inquiries including Project Breakthrough, Tomorrow's Capitalism Inquiry, and the Green Swans Observatory. In 2021, he won the World Sustainability

IN THIS CONVERSATION WITH GRIHA COUNCIL, JOHN ELKINGTON DISCUSSES THE CONCEPT OF THE TRIPLE BOTTOM LINE, THE NEED TO EXAMINE CLIMATE-DESTABILIZING COMPANIES AND CORPORATE SUSTAINABILITY, AND THE IMPORTANCE OF RESILIENCE IN BUSINESSES AMONG OTHER

GRIHA: *Your book Cannibals with Forks: The Triple Bottom Line of 21st Century Business was released in 1997, yet it still holds relevance. Can you tell us about the book's message?*

John Elkington (JE): Well, that seems like a lifetime ago. It was my 13th book—and I have written another seven since then. But it certainly had an impact on the corporate responsibility agenda. The concept of the triple bottom line, which I developed in the book, went viral, as we would now say. It inspired and informed the evolution of organizations like the Global Reporting Initiative (GRI), the Dow Jones Sustainability Indices (DJSI), and the B Corporation movement.

I am proud of the impact it had, and it has become a standard feature of business education, but I have also been critical of how it has been applied in some areas. So, here's a question. How often are management concepts subjected to product recalls by the people who coined them?

It is hard to think of a single case. By contrast, if an industrial product like a car fails in a well-run market, the manufacturer pulls it back, tests it, and re-equips it if necessary. In case manufacturers become careless, governments regulate and run periodic road safety tests to ensure that public safety is being accounted for. Management concepts, by contrast, generally operate in poorly regulated environments where failures, too often, are swept under boardroom or faculty carpets. Yet, poor management systems can jeopardize lives in the air, at sea, on roads, or in hospitals. They can also put entire businesses, sectors, and economies at risk. With this in mind, I announced the first-ever recall of a management concept via the Harvard Business *Review*[1]. This was the year before 2019, which marked the 25th anniversary of the triple bottom line, a term I had coined in 1994 to mean a sustainability framework that examines a company's social, environmental, and economic impact. We announced the recall to do some 're-engineering'.

As it happened, it turned out that I had dodged a bullet, even if that was not part of my intention. A few months later, Anand Giridharadas published his provocative book, *Winners Take All*.[2] With a reputation for skewering plutocrats, Giridharadas argued that the wealthy are using philanthropy to pretend they are changing the world, while maintaining the status quo. Even such well-received interventions as BlackRock CEO Larry Fink's letters to shareholders, encouraging greater action on ethical, social, and environmental matters can be seen as an evasive tactic as long as BlackRock continues to hold shares in climate-destabilizing companies like ExxonMobil. Nor did Giridharadas have much time for the triple bottom line, at one point quoting our recall of the concept. About 25 years of corporate sustainability have not halted, let alone reversed, the global destabilization of our climate and the accelerating loss of species. It is time, we conclude, to think—and act—differently. We worked to reframe the triple bottom line approach during our subsequent Tomorrow's Capitalism Inquiry,[3] arguing the need to use my 3-D value concept in the context of a necessary—and rapidly evolving—shift from **Responsibility** to **Resilience** and **Regeneration**.

Responsibility is a necessary condition of change, of course, but evidence suggests growing instability in our economic, social, political, and environmental systems—as underscored by the climate and biodiversity emergencies. That's why we increasingly hear politicians, business leaders, and investors talking about 'resilience'. But the best way to deliver true, long-term resilience is not to talk about it but to regenerate all the systems on which our future health and well-being now depend. For more on that agenda, take a look at Paul Hawken's brilliant new book, Regeneration: Ending the Climate Crisis in One Generation.[4]

GRIHA: *In a developing country like India, how can the triple bottom line inform economies of scale?*

JE: Let me draw on the thinking and work of my friend and former colleague Shankar Venkateswaran, now, among other things, Chairman of Oxfam India.[5] As a concept, ESG (environmental, social, and governance) is being talked about by people in the financial world, and even more so in the COVID-19 era. This term has been around since 1987 and is investor-speak for 'Sustainability'. The financial world has embraced this idea, which is reminiscent of the blind men encountering different parts of the proverbial elephant. All seize different bits—and all have very different mental images of what they are encountering.

ESG seems to follow a similar pattern and its three components tend to be seen separately in silos, therefore, their complex interrelations are often overlooked. ESG discussions tend to

[1] For more details, please visit https://hbr.org/2018/06/25-years-ago-i-coined-the-phrase-triple-bottom-line-heres-why-im-giving-up-on-it
[2] For more details, please visit https://www.penguinrandomhouse.com/books/539747/winners-take-all-by-anand-giridharadas/
[3] For more details, please visit https://volans.com/tomorrows-capitalism-inquiry/
[4] For more details, please visit https://www.penguinrandomhouse.com/books/690153/regeneration-by-paul-hawken/
[5] For more details, please visit https://theobservatory.volans.com/wp-content/uploads/2021/08/GSO-SV-JE-edit-24-07-2021.pdf

converge into one overarching theme i.e., climate change mitigation – that is, reducing greenhouse gas (GHG) emissions through renewable energy (RE), electric vehicles (EVs), and wider net-zero strategies.

Reading–or listening–between the lines of exchanges will lead to only a fleeting discussion on the 'S' part of the formula. This usually grinds to a halt around diversity. And if we think about India, the conversation rarely goes beyond gender. That, sadly, seems to be the 'be-all-and-end-all' of ESG!

Anyone who has watched the ESG agenda evolve from early discussions on the triple bottom line will be able to understand that there is far more to it than that, especially in emerging economies like India. As companies outsource their activities, their dependence on supply chains increases and this is where they become extremely vulnerable to the 'S' agenda.

This was true before the COVID-19, but the pandemic harshly spotlighted the plight of informal workers—many of them migrants—who make up the base of the economic and (not coincidentally) social pyramid, mired via exclusion on accounts of gender, caste, identity, disability, and so on. Such people make a massive contribution to India's wealth, generally by working in MSMEs (micro, small and medium-sized enterprises), which are themselves an integral part of the supply chains of large companies, in construction (at building sites, most obviously, but also in the production of red bricks, stones, sand, aggregates), in the gig economy, and as contract and casual labour.

Their term of employment precisely characterizes the lack of terms of employment. Human rights violations are the norm, be it in wages, working and living conditions, and safety—with scant, if any, investment made in training. This is the Achilles' heel of most companies in India, which have little visibility on human rights issues beyond their tier-1 suppliers.

Another critical component focuses on communities around production sites. Many people, most likely involuntarily, gave up the land on which a factory or other facility has been built. Apart from any (and very likely inadequate) compensation they may have received at that time, they now get very little benefit from the development. India's government may mandate that 2% of company profits must go to CSR projects, but even if that money filters through, it is unlikely to compensate for the huge costs of pollution, water use, and other disruptions.

Worse, the COVID-19 pandemic has driven huge numbers of people back to their villages. With extremely limited employment opportunities, communities are increasingly expecting more from companies that have plants in their midst. Since communities now provide the 'license to operate', at least some companies are waking up to the need to respond proactively and positively to community needs and aspirations to ensure business continuity.

Another 'S' component is safety. While most established companies invest in safety training, processes and equipment, much of this is restricted to their own workforce. What is less clear is the extent to which these investments cover contract and casual labour working in their plants. And too often, firms also fail to track related investments made by suppliers, despite the fact that accidents and casualties in supply chains can disrupt their own operations. Thus, it is in the interests of companies that they continuously expand the scope of safe operations.

Hence, the 'S' story and the parallel convergent stories for the economic, environmental, and governance dimensions too are present. Given space constraints, those have to be stories for another time!

GRIHA: *Do the environmental benefits seen as a result of this global slowdown (less smog, less turbid waterbodies, etc.) hint at the potential positive impacts of green economies?*

JE: Yes, they do, as in the experience of radically clean air in many cities and in countries like China, at least for a while. The return of wildlife was also enjoyed by many. But GHG emissions are now kicking up again, so the benefits will be short term. So, we have had a glimpse of what could happen if we acted in a timely and effective manner—our challenge is now to do precisely that.

GRIHA: *Businesses and individuals have suffered a great deal due to the COVID-19 pandemic. As we look towards restarting businesses, what are the ways in which we can sustainably restore/reform economies?*

JE: We have recently worked with the World Business Council for Sustainable Development (WBCSD) to examine the structural transformation of capitalism necessary to realize WBCSD's 'Vision 2050' (over nine billion people living well within the means of the planet) and the role of business in bringing about those transformations. The report, *Reinventing Capitalism: A Transformation Agenda*[6] argues the case for radical reform:

Capitalism and its consequences for society and the environment are very much in the spotlight. Even committed capitalists are beginning to argue that capitalism, in its current form, is unsustainable—socially, environmentally, and economically. Yet capitalism's core features of private enterprise and competitive markets are essential to addressing our greatest societal challenges and unleashing the transformations required to meet the Sustainable Development Goals (SDGs).

Reinventing Capitalism synthesized the best available thinking on why capitalism needs to be reinvented if it is to create the conditions for long-term business success, and the actions that business, investors, and policymakers can take today to drive transformation. A key message of the work was that – 'now is the time for companies and investors to enter—and lead—the debate, not just about why capitalism needs to change, but about how we (must) go about transforming it.'

The capitalism we need is one that rewards true value creation—not value extraction as today's model does. This means that all social and environmental costs and benefits should be internalized and reflected in the relative price of goods and services, and in companies' profit and loss statements, costs of capital and market valuations.

The WBCSD report argues that if we are to get to such a version of capitalism, we need to realign the incentives that drive businesses and investors' behaviour, adopt new and better ways of measuring performance, and tackle failures at the market and institutional levels that favour financial value extraction over true value creation. A reinvented model of capitalism that addresses these failures will be characterized by five features, namely, stakeholder-oriented, impact-internalizing, long-term, regenerative, and accountable.

Reinventing capitalism along the lines suggested will, undoubtedly, be very challenging. It will require

[6] For more details, please visit https://www.wbcsd.org/Overview/About-us/Vision-2050-Time-to-Transform/News/Reinventing-capitalism-WBCSD-lays out-a-transformation-agenda-for-business

complementary action from businesses, investors, and policymakers, supported by voluntary action from the private sector apart from necessary changes to law and regulation going hand in hand. Business, therefore, has a critical role to play in shifting capitalism, involving the following:

- 'Walking the talk'—adapting and aligning business models, decision-making processes, governance models, incentives, approaches to tax, remuneration, reporting and accounting with a vision of capitalism that pursues true value;
- Leveraging relationships with other stakeholders—from suppliers and customers to policymakers and civil society—to influence the norms and rules that shape capitalism as a whole.

GRIHA: *We interact with multiple stakeholders from business owners to developers and project teams to impart knowledge around building sustainability. How can our discourse be made more impactful for this target audience?*

JE: The key tasks involve linking leading thinkers and practitioners in all sectors and across geographies. We need to bring forward younger people faster than would normally be the case—after all, this is their future, and they are likelier to care about it than the sort of people who populate corporate boards and government cabinets today.

Since resilience and regeneration are systemic properties, the implication of this for corporate leadership is a shift in priorities from internal process optimization to nurturing external relationships that bring opportunities to transform markets to better serve people and the planet. Functions like procurement and government affairs are, therefore, central to the story of how business plays a key role in ensuring a positive systemic change. The COVID-19 pandemic has put the resilience of global value chains in the spotlight. Over time, the ever-harder-to-ignore necessity of regenerating communities, ecosystems, and economies will mean that procurement teams will find themselves under increasing pressure to use their purchasing power in a regenerative way.

» Reinvention summit

GRIHA: *What systemic reforms and policy interventions are required to prepare for the future?*

JE: My latest book, Green Swans,[7] was published in April 2020, leading to my being asked to deliver over 100 virtual keynotes in more than 30 countries by the end of 2020 alone. We were continuously asked for more information and case studies linked to people's own sectors, markets, and challenges. Our online Observatory[8] is our response designed to provide constantly updated intelligence on exponential solutions to some of the world's greatest challenges.

We look forward to a future world turned upside down with our species in service of life rather than vice versa. We urgently need exponential solutions to the rising problems. So, the Observatory spotlights exponential shifts in mindsets, markets, technology, politics, and cultures that, directly or indirectly, can enable a 'Regenerative Economy'. Shifts we call 'Green Swans'.

Launching with a Green Swans Day event in 2019, our linked change agenda took wing at the 2020 Tomorrow's Capitalism Forum we co-hosted with Aviva Investors. The idea is easily stated–a 5-year campaign to ensure regeneration is firmly on the board and C-suite agenda by 2025.

We are in the midst of a planetary, multigenerational re-education process. Education, at all levels, is among the best investments our societies make with extraordinary (if not always predictable) long-term returns.

So, one strand of the Observatory has worked with university and business school students in Japan, the UK and USA, typically at the MBA and Master's level on Green Swan market forecasts and linked policy and entrepreneurial solutions. So, a few things give us greater hope that we can crack this problem—before it cracks us.

[7] For more details, please visit https://volans.com/project/green-swans/

[8] For more details, please visit https://theobservatory.volans.com/

ASSAM HOUSE, NEW DELHI

The Assam House, situated at Gopinath Bordoloi Marg, Chanakyapuri in New Delhi is a '4-Star' GRIHA-rated building. It showcases an integrated design and execution efforts from the entire project team of PWD, Government of Assam.

PROJECT TEAM

Client:
PWD, Government of Assam

Project Coordinator:
Office of Executive Engineer, PWD; Assam Pavilion Building Division, New Delhi; SBP Commercial P Limited

Principal Architect:
D.K. & Associates, New Delhi

Landscape Architect:
D.K. & Associates, New Delhi

Project Management:
Chief Engineer, PWD (B) Assam, Guwahati

Structural Consultant:
Chief Engineer, PWD (B) Assam, Guwahati

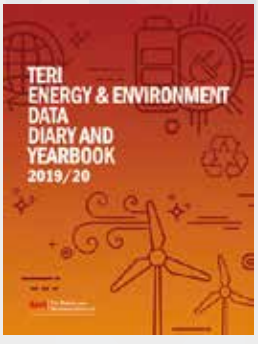
Electrical Consultant:
Additional Chief Engineer (E), PWD (B) Assam, Guwahati

Green Building Consultants:
M/s Passive Design

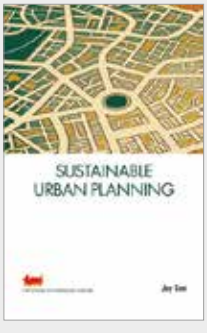
The mixed-use, re-development project comprises two building blocks meticulously designed to save most of the existing trees and integrate them in the new landscape. These trees also provide ample shade to the building façades while enhancing the overall ambience. Building roofs have been designed to integrate maximum solar energy harnessed through 50 kWp photovoltaic panels and 5000 litre/day hot water panels that further reduce heat gain from the roofs. Recessed windows with double glazing optimize solar heat gain and glare in the building interiors. The building envelope also uses AAC blocks for wall insulation and XPS insulation for the roofs. Smart interior lighting, energy-efficient VRV (variable refrigerant volume) air conditioning system, and building management system (BMS) help achieve an EPI (Energy Performance Index) of 53.4 kWhm^2 while saving more than 86% from the GRIHA energy benchmark. By utilizing low-flow sanitary fixtures, efficient landscape irrigation systems, and reusing treated waste water, the project saved over 50% of the required freshwater. The team of GRIHA Council was instrumental in extending their invaluable support by guiding the project team throughout the execution stage, especially during the final documentation.

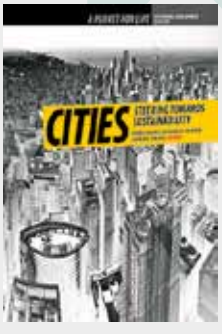
PUBLICATIONS ON SUSTAINABLE ARCHITECTURE

Rejuvenating Resilient Habitats



Available in print and digital formats





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Extended Producer Responsibility

Scope and Examples in India

Businesses must create inclusive environments that promote sustainable production while benefiting the local community. In this article, **Abhas Mukherjee** and **Rashi Goel** discuss the relevance of ethical manufacturing and highlight the importance of the Polluter Pays Principle to ensure sustainable development.

We live in an era of industrialization. We need manufacturers and businesses for producing different goods and products for consumers. But, wouldn't it be worthwhile if all the manufacturing processes in the world are such that they do not cause harm to the environment in the form of different kinds of pollution and other negative effects of manufacturing such as degradation of the natural environment? Therefore, the challenge before

Abhas Mukherjee holds a Master's degree in Conservation and Heritage Management from DIHRM, New Delhi, and currently works as Editor at TERI Press. As a seasoned science communicator, he has contributed exclusive pieces on science and environment in both English and Hindi for publications such as *Science Reporter, Dream 2047, Invention Intelligence, Bal Bharati*, and *Jansatta*. He can be reached at abhas.mukherjee@teri.res.in.

Rashi Goel obtained her Master's degree in Communication Management from Symbiosis Institute of Mass Communication. She writes on environmental issues for publications such as *TerraGreen*, and blogs at www.greenokplease.org about ways in which people can start living healthy by adopting sustainable lifestyles. She can be reached at greenokplease@gmail.com.

manufacturers is how to achieve an ethical status while improving their business processes. In such a scenario, wouldn't it be justified and equitable to follow the 'Polluter Pays' Principle?

What is the 'Polluter Pays' Principle?

In simple terms, the 'polluter pays' principle states, 'Those who pollute should pay for the cost of the pollution they create.' It is the commonly accepted practice that those who cause pollution should bear the costs of managing it to prevent damage to human health or the environment. For example, a factory that produces a potentially poisonous substance as a byproduct of its activities is usually held responsible for its safe disposal. The polluter pays principle is part of a set of broader principles to guide sustainable development worldwide (formally known as the 1992 Rio Declaration).[1] However, is it really possible to determine the cost of an ocean polluted with oil spills or the extinction of an entire species due to chemical pesticides?

The answer to the aforementioned question would be 'No'. Even if industrial producers adhere to the 'polluter pays' principle, they would do better by following ethical manufacturing processes.

What Is Ethical Manufacturing?

Ethical manufacturing is a holistic approach to the manufacturing process that focuses on good health for all involved. This means that a product's design, creation, and use can maintain sustainable standards. As a result, the products and the processes of making these have a positive impact on communities.

Businesses must create inclusive environments that promote sustainable production while benefiting the local community. An ethical manufacturer has a broadened vision and cares for every section of their business and their own supply chain, prioritizing the well-being of their customers, staff as well as the environment. Ethical production may include material and energy use. Ethical manufacturing businesses do not just have to rely on material sustainability – the ethical impact can extend to their workers as well. By utilizing sustainable processes and materials, manufacturers ensure that local ecosystems are affected in the minimum possible manner. Sustainably sourced materials may include recycled goods or items sourced from another local manufacturer. This reduces waste and limits transport needs, which can have a negative environmental impact.

Some toilet paper companies plant trees to replace the ones used for their production. One of the leading manufacturers Procter & Gamble (P&G) Co. plants a tree for each one that is felled by them. It also pays to protect trees in other parts of the world as a way of offsetting some of its greenhouse gas (GHG) emissions. P&G further states, "Every decision we make is guided by what is best for consumers and the environment. P&G has committed to using recycled fibres where it can have the most benefit for our consumers."[2]

What Is Extended Producer Responsibility?

The concept of Extended Producer Responsibility (EPR) is that the responsibility of the producer of a product is extended beyond conventional sales to its post-consumer or End-Of-Life (EOL) stage. This means that the producer is responsible for collection of the used products or packaging

[1] The London School of Economics and Political Science. 2018. What is the polluter pays principle? Details available at https://www.lse.ac.uk/granthaminstitute/explainers/what-is-the-polluter-pays-principle/

[2] Porter Jr, Gerald. 2020. 'You May Be Cleaning Up in the Bathroom Using an Old-Growth Tree.' In Bloomberg Green. Details available at https://www.bloomberg.com/news/articles/2020-09-17/how-green-is-your-toilet-paper-brand

material and ensuring its safe recycling or disposal. EPR is also known as 'Product Stewardship' and extends the responsibility of the producer beyond the point of sale of the product, that is, up to the EOL of the product. The idea behind EPR is to encourage producers to consider the EOL processing of their products right from the design stage, thereby designing products which are both long lasting and easily recyclable. There is a substantial cost of collection and recycling of this waste, which should be borne by the producer and not be passed on to the government or the environment.

Let us talk about Tetra Pak to understand this concept better. Tetra Pak is a packaging and processing solutions provider. While it was a resourceful innovation in food packaging that increased the lifespan and portability of fresh foods, the material also led to tremendous pollution. The fused materials take a very long time to be broken down by natural bacteria and therefore, are practically non-biodegradable.

So, Tetra Pak came under a lot of criticism for the impact caused by their post-consumer waste. This led the organization to try and take the responsibility of their products by working with various stakeholders across the country, such as collection agencies and recyclers to collect the waste. They then worked to recycle their cartons into various products, such as roofing sheets, chipboards, stationery items, desks for schools, and so on. Eventually, they redesigned their entire product by adopting completely biodegradable material.

So, we see that apart from minimizing environmental degradation, EPR also encourages producers and brands to reduce the costs associated with EOL products by designing better, longer-lasting products, making them suitable for an exchange, an upgrade or even for recycling. Further, under EPR, producers may also have a greater say in how a company takes back its products and how recycling schemes operate, thereby enabling them to get better access to secondary materials for their own supply chains.

Sustainability was earlier driven by consumer preferences, and that is still relevant. However, brand owners now value sustainable practices too, and not just to satisfy the consumer. They understand its importance to the planet, and that it is a fundamental requirement for the

long-term viability and productivity of their business. Sustainability is no longer a niche trend, but something that these businesses really believe in and are leading the charge for, especially in the packaging industry.

To give you another example of EPR, let us consider the case of ITC. In October 2019, Fast-Moving Consumer Goods (FMCG) major ITC introduced the country's first Multilayered Plastic (MLP) collection and recycling initiative in Pune, tying up with a waste-pickers' cooperative – Solid Waste Collection and Handling (SWaCH) – and recyclers, such as Shakti Plastic to ensure sustainable plastic waste management.[3] MLP is difficult to recycle and poses a major challenge to all stakeholders as far as the use of plastic is concerned. User industries, including packaged food companies, argue there is no replacement to MLP, which basically consists of multiple layers of plastic and other materials such as aluminium foils, paper, paperboards, etc. But waste collectors and ragpickers typically don't collect this waste (MLP). As a result, streets, dumps, and sewage canals are littered by this waste. To counter this, ITC stepped in buying MLP waste from garbage collectors at the very beginning and then sorting it with the help of SWaCH before sending it to recyclers such as Shakti Plastic. At the recycling unit, ITC invested in technology to help convert the MLP waste into pellets, used for making daily items, such as plastic chairs, stools, buckets, mugs, and so on. It is an end-to-end solution where sustainable plastic waste management is the ultimate objective.

Challenges in Implementation of EPR

While it is worthwhile for companies to tackle the issue of plastic waste management through the EPR programme that makes it mandatory for firms to take back the plastic waste generated by their products, there are some challenges too in the implementation of EPR that include the following:

- Segregation of waste at source is key for resource recovery of EPR products. Producer companies must contribute significantly to improve awareness of source segregation and the need to recycle.
- Plastic waste and electronic waste are spread across the country. There is a lack of formalized reverse logistics companies as setting up a collection network could be extremely complex and expensive.
- The informal sector manages around 90% of all waste streams. Upgrading these to the formal means of responsible waste management while ensuring their adherence to compliances is challenging.

Scope of EPR in India

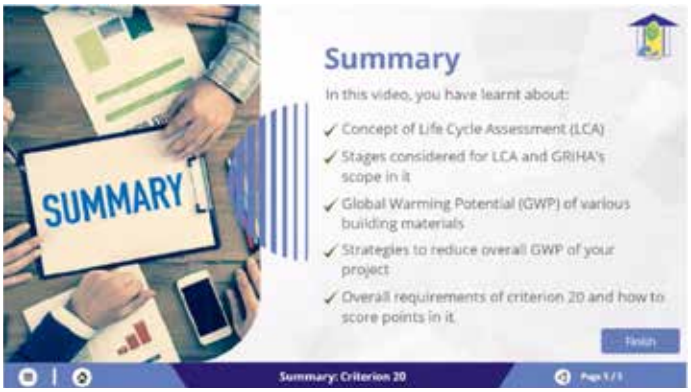
In 2016, in India, the concept of EPR was brought into the Plastic Waste Management Rules, 2016. In Maharashtra, the government has introduced a *buyback mechanism*. In this mechanism, the manufacturer is supposed to print their name, the type of plastic used, and a recycling price/buyback price on their product. They are then supposed to buy it back from the consumer at that price and send it to the recycling units. EPR policies should bring about effective collaborations between various stakeholders, such as the central and state governments, producers, consumers as well as the informal sector to effectively mitigate the effects of climate change and pollution caused by plastic waste. Stringent EPR policies would be instrumental in ensuring the implementation of the sacred 3R principle (reduce-reuse-recycle), hence facilitating a circular economy.

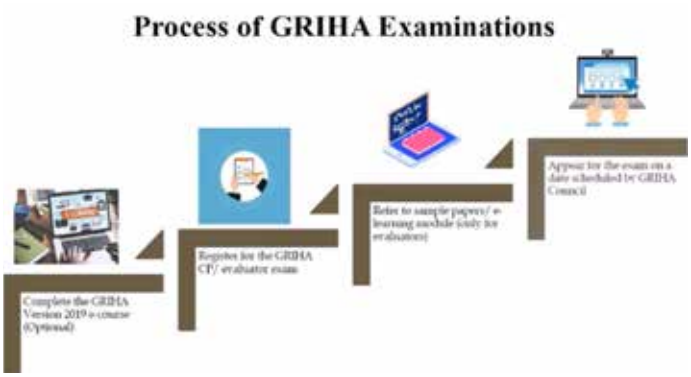
[3] Pinto, V. S. 2019. 'ITC launches first multilayered plastic collection, recycling drive in Pune.' In Business Standard. Details available at https://www.business-standard.com/article/companies/itc-launches-first-multilayered-plastic-collection-recycling-drive-in-pune-119100201010_1.html

GRIHA LEARNING CENTRE

An e-learning platform for GRIHA trainings and examinations

The GRIHA Learning Centre has been developed as a massive step towards bridging the gap between green rating and sustainability integration. Design, development and propagation of the 'green infrastructure' demand a large pool of qualified professionals in all parts of the country. To enable the active dissemination of knowledge and skills necessary for designing green buildings, GRIHA Council is switching its training programmes to the e-learning platform. The primary aim of the learning centre is to enhance the outreach and to ensure that it is easily accessible to every individual across the nation.





E-COURSE ON GRIHA VERSION 2019

Our own team of professionals is hosting the course on GRIHA v.2019 and is sharing their first hand experiences while disseminating the knowledge on complex concepts of sustainability. The course will be elaborating on criteria requirements of the GRIHA v.2019 through interactive sessions and thought provoking quizzes. Interested professionals can also be associated with GRIHA Council by becoming GRIHA Certified Professionals and/or GRIHA Evaluators after attending this programme. The GRIHA Learning Centre aspires to bring them all together under one umbrella and cultivate a positive atmosphere for knowledge sharing and learning.

Financing Low Carbon Transitions in India

India is the fourth highest emitter of CO_2 in the world. In this timely article, **Gaurav Varshney** looks at low carbon transitions from a financial perspective to understand the feasibility of various financial instruments, such as carbon pricing and green bonds, in the context of developing countries like India.

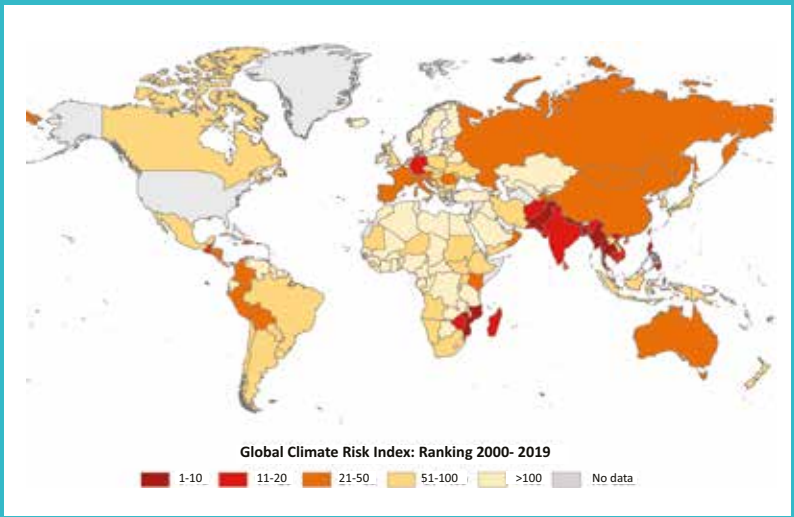
Gaurav Varshney is an architect who is pursuing his Master's in City Planning from the Indian Institute of Technology, Kharagpur. He has an experience in the fields of highly efficient, green-rated contemporary design and cost-effective, frugal vernacular architecture. Currently, he is researching the various approaches to low carbon development in mass housing projects. He can be reached at ar.gaurav95@gmail.com.

Introduction

Climate change is the most common cause of disasters–both natural and human-induced–the world is grappling with today. India is one of the most vulnerable countries to climate change risks, and ranks seventh worldwide in the Global Climate Risk Index (2000–2019) (Figure 1).

The annual monsoons in India, which continue for about four months, have adverse effects on the environment. In 2019, the alterations in the monsoons were observed to be erratic, and the season continued for a month longer than usual. This led to extreme events such as floods that claimed as many as 1800 deaths amounting to an economic loss of over US$10 billion, as per the Global Climate Risk Index, 2021. The effects of climate change are already visible in terms of changes in rainfall patterns, high temperatures, increase in sea level, and frequent occurrences of cyclones, storms, and landslides. According to the latest Intergovernmental Panel on Climate Change (IPCC) report published in August 2021, if we continue to emit greenhouse gases (GHGs) as per current trends, global warming will surpass the 20°C rise by mid-2100s.

The irregular patterns of climate change beg an urgent transition to low carbon developments. If these transitions are not implemented on a war footing, the social and financial implications will become irreversible causing an inevitable slowdown in the fast-paced growth of the Indian economy.



» **Figure 1:** Global Climate Risk Index (2000–2019)

Current Situation in India

India is the fourth highest emitter of CO_2 (Figure 2), and although the per capita emissions of our country are low at 1.8 tonne of CO_2 when compared to the world average of 4.2 tonne per capita, the emissions have been growing at a steady rate of 6% since the past decade (Andrew 2021). Looking at the rate of development in the country, low per capita carbon emissions, and the growing population, it becomes evident that with time, carbon emissions are only going to escalate. The most common component of these emissions is the energy sector, which is predominantly dependent on the diminishing stock of non-renewable sources in India, primarily coal.

India targets 40% of its electricity generation capacity by 2030 from non-fossil sources as per the Nationally Determined Contributions (NDCs) under the Paris Agreement. India has taken immediate steps by focusing on energy transitions through initiating various target programmes, such as reaching the goal of 175 GW of installed renewable capacity by 2022. In its path towards a low carbon economy, India is also focusing on other energy-intensive sectors, such as heavy industry and transportation through the incorporation of dedicated freight corridors and electric public vehicles.

As per the estimates by National Institution for Transforming India (NITI Aayog), India needs around US$834 billion till 2030 for mitigating carbon emissions through low carbon developments. At this point, it becomes crucial to move from carbon subsidy schemes to carbon taxation policies. In this regard, green finance can play a crucial role in diverting capital from the carbon-emitting sectors to the carbon-mitigating sectors (Krogstrup and Oman 2019).

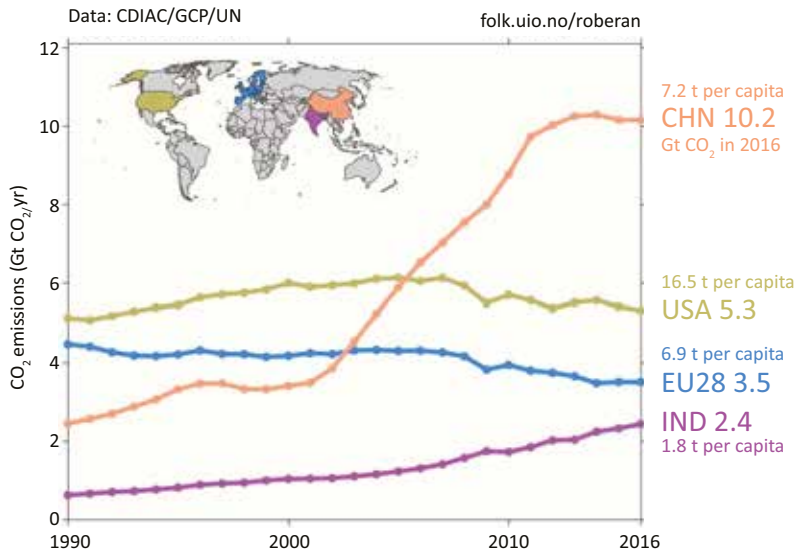
Green Finance

In its efforts of transitioning to a low carbon economy, India must mobilize its capital from both the public and the private sectors to meet its international commitments. However, there are certain barriers to financing the green sector, which are listed as follows:

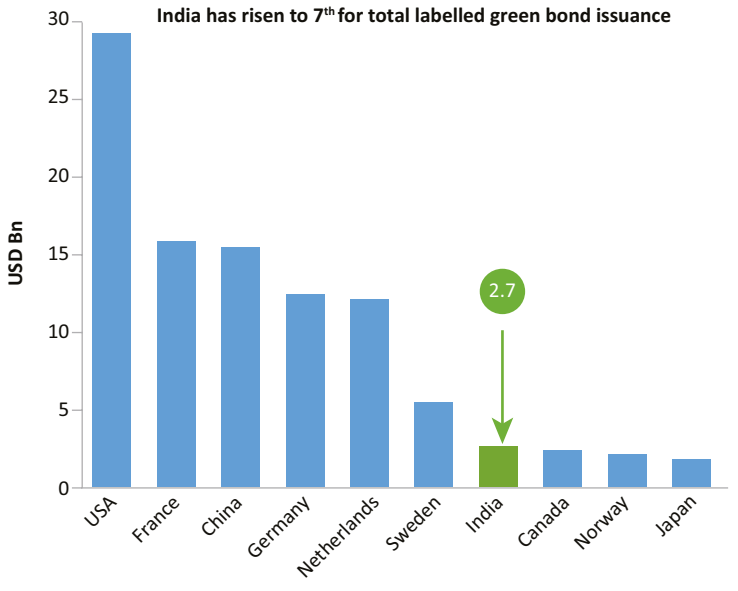
- Limited information on assessing financial risks and deficiency of proper tools;
- Long-term timeline of low carbon development;
- Lack of environmental factors and inputs in finance budget;
- Lack of proven technologies in financing low carbon developments.

The financial policy instruments for mitigating carbon emissions can be categorized as regulatory and market-based instruments. The regulatory instruments involve large-scale implementation of low carbon frameworks, such as regularizing renewable sources of energy as the primary source of energy consumption. This is a long-term approach and needs huge capital investments. The market-based instrument involves subsidies, taxing, and imposing levies on the carbon-emitting organizations. As per the global data, the market-based instruments are divided into two major tools – carbon pricing and green bonds. We will now look at these market-based instruments as they are more feasible in the short to medium term.

Green bonds (Figure 3) are standard income instruments aimed to finance green assets. These are usually issued in the fields of Renewable Energy (RE), transportation, energy efficiency, green building, waste management, land use, and water management. Since its inception in 2007, the issuance of green bonds has seen a tremendous rise with India–ranked seventh in the world–having released green bonds of around



» **Figure 2:** India's carbon emission rate; Source: (Andrew 2021)

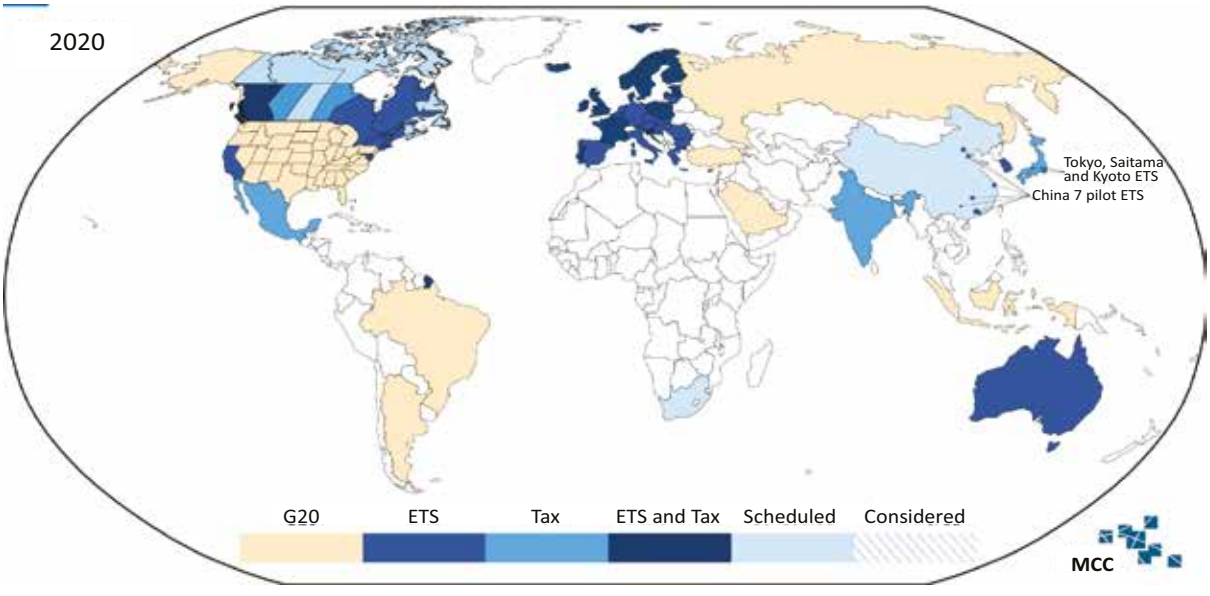


» **Figure 3:** Total labelled green bond issuance (Patzdorf 2016)

US$2.7 billion by 2016. The current statistics indicate that by the first half of 2019, India released US$10.3 billion worth of green bonds. Over 60% of the labelled green bonds in India go in funding RE projects so that the target of 175 GW of installed RE by 2022 is achieved sooner than later. India has potential of becoming a prominent leader in raising capital through green bonds with benefits such as transparency, excess capacity expansion cash flow, low operational risks, and others.

Carbon pricing has been successful in developed countries and is still a work-in-progress in developing countries like India (Figure 4). According to International Monetary Fund (IMF), the world needs a global tax of US$75 per tonne by 2030 to reduce emissions to a level consistent with the 20C warming target (Parry 2019). Carbon pricing can be levied through two methods that include a carbon tax charge and a cap-and-trade system. In carbon tax charge, a tax rate is defined by the government for carbon emitters. In the cap-and-trade system, the government puts a limit on the total emissions and allows industries with lower emissions to trade their carbon credits to the larger industries, thus maintaining the total cap on one sector. Due to the lack of a standardized taxing system, this financial tool can make the discrepancies in the countries visible.

India, for instance, lacks an effective market-based carbon pricing system but it does have a related mechanism



» **Figure 4:** Uptake of carbon pricing in G20 nations (***Source:*** *Funke and Mattauch 2018*)

for pricing the carbon as mentioned below:

- National Energy Policy 2020;
- Perform, Achieve and Trade (PAT) Scheme;
- Renewable Energy Certificates (RECs);
- Internal Carbon Pricing;
- Coal Cess 2010.

For developing countries such as India, some of the challenges on pricing carbon include scattered benefits creating political unwillingness, households' disinterest in paying a carbon tax, and other hurdles in the growth of developing countries. In a country like India, carbon pricing schemes must be formulated after considering the political and behavioural implications on the government and the general public. Carbon pricing policies should be flexible, must have equalized marginal cost of abatement, and be more beneficial than conventional regulations to the individuals, in addition to being centred on revenue generation.

The Way Forward

This article made an attempt to understand the complexity of financing low carbon developments through a brief discussion on two policy instruments, including carbon pricing and green bonds. In India, the debt level is increasing with each passing day and as per the estimation by IMF, it will cross 80% of the GDP by 2021. Hence, India should think of both short-term and long-term approaches. In the short-term approach, carbon pricing does not seem a viable option as the high carbon taxes are opposed by both political and public groups. The government should focus on minimizing the subsidies given on fossil fuels and work towards maximizing the issuance of an implicit price on carbon through green bonds. In the long-term approach, as seen in other countries, India must consider using both green bonds and carbon pricing for financing low carbon developments, as the global costs of renewables are already on the decline, thereby encouraging the companies to shift to renewable sources of energy generation. With the strategic strengthening of the digital infrastructure through missions such as Digital India, and by creating a dialogue to understand the importance of carbon pricing among citizens, our country exhibits immense potential of leading the world to a low carbon future.

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Training Programme on the DOs and DON'Ts of GRIHA Version 2015 Documents

A six-day intensive training programme was conducted by GRIHA Council on the DOs and DON'Ts of GRIHA Version 2015 documentation.

GRIHA Awareness Programme

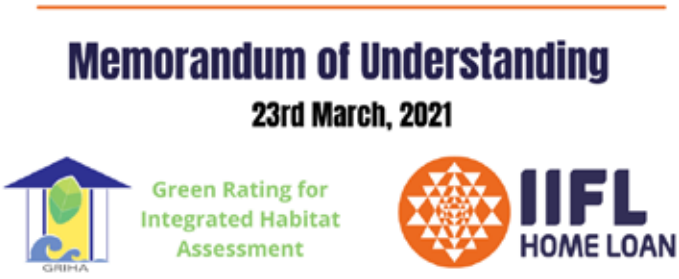
World Environment Day was celebrated by GRIHA Council to spread awareness among people to protect the environment for a healthier and better future.

Council of Architecture Online Training Program in collaboration with GRIHA Council presents:

"GREEN BUILDINGS - THE GRIHA WAY"

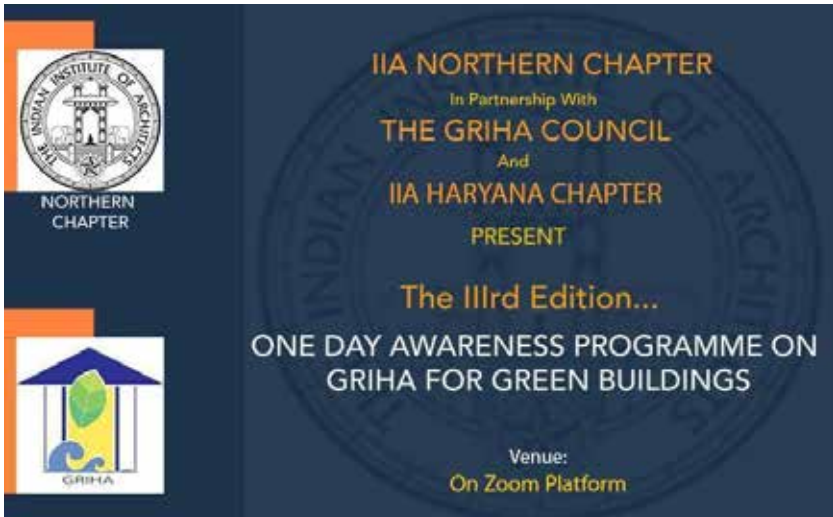
Webinar on Green Buildings – The GRIHA Way

A 15-hour training-and-awareness online programme was held over five days, which included sessions on all aspects of building design, construction, and engineering that play a crucial role in the assessment for GRIHA Rating.



MoU between GRIHA Council and IIFL HL

Mr Monu Ratra, Chief Executive Officer and Executive Director, IIFL HFL and Mr Sanjay Seth, Chief Executive Officer, GRIHA Council signed the MoU on behalf of both the organizations. This collaboration is for the promotion and implementation of green building concepts and their evaluation using the GRIHA rating system pan India.



3rd GRIHA Consultants Meet

The Consultants Meet was attended by 84 participants and the focus was on the rating process and detailing of GRIHA v 2019.

GRIHA Virtual Fest

The GRIHA virtual fest was organized to give a platform to various stakeholders, such as builders, architects, NGOs, manufacturers, academicians, and government agencies to showcase their products and services.

MoU between GRIHA Council and KIIFB

Dr K M Abraham – Chief Executive Officer, KIIFB and Mr. Sanjay Seth, Chief Executive Officer, GRIHA Council signed the MoU on behalf of both the organizations. This collaboration is for the promotion and implementation of green building concepts and its evaluation using the GRIHA rating system in the state of Kerala.

MoU between GRIHA Council and CIMSME

A MoU was signed between GRIHA Council and the Confederation of Indian Micro Small and Medium Enterprises (CIMSME) on February 19, 2021 on a virtual platform. Mr Santhosh Ganesh - Founder, CIMSME and Mr Sanjay Seth - CEO, GRIHA Council signed the MoU on behalf of the organizations.

One-Day GRIHA Awareness Programme for Members of Indian Institute of Architects, Northern Chapter

A one-day GRIHA Awareness Programme was held for the members of the Indian Institute of Architects, Northern Chapter. As part of the event, a memorandum of understanding (MoU) was signed between GRIHA Council and Indian Institute of Architects, Northern Chapter.

GRIHA Council signed a Memorandum of Understanding (MoU) with Energy Management Centre and International Institute for Energy Conservation on December 16, 2020 for the promotion and implementation of GRIHA.

GRIHA Council signed a Memorandum of Understanding (MoU) with Energy Management Centre and International Institute for Energy Conservation on December 16, 2020 for the promotion and implementation of GRIHA.

Valuing Cultural Ecosystem Services Associated with Urban Forests

Forests are the lifeline of our ecology. However, with globalization and industrialization, extreme land degradation and depletion of forest cover have caused disruption in our environment. In this article, **Poonam Saini** and **Dr Aarti Grover** discuss the importance of urban forests and highlight the relevance of strengthening the cultural ecosystem services (CES) to manage natural resources by ensuring their conservation and sustainable use.

Poonam Saini, a landscape architect with an experience of about 19 years, is presently pursuing her PhD from SPA, Delhi. Her areas of interest are urban landscapes, energy-efficient and sustainable landscapes, and landscape economics. As an associate at leading firms in the city, she has been responsible for master planning, landscape design, and execution of numerous projects including commercial, residential, institutional, recreational, and townships. She can be reached at poonamsaini.ska@gmail.com

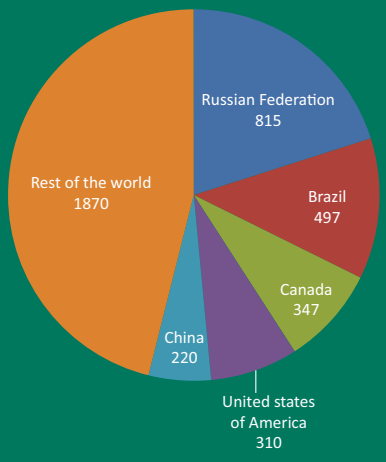
Dr Aarti Grover is Head of Department and Associate Professor of Landscape Architecture at SPA, Delhi. She possesses a multidimensional experience of 20 years in academics and research. Trained as an architect, she specializes in landscape architecture, and believes in creating inclusive spaces rooted in natural and social contexts for meaningful interactions at multiple levels. She can be contacted at a.grover@spa.ac.in.

Introduction

Land is one of the most important natural resources for human sustenance. Terrestrial ecosystems function best when left untouched and undisturbed. However, the world population has risen exponentially over the decades leading to expansion of urban areas. Consequently, land use and degradation have resulted in changes in the structure and functioning of ecosystems, their ability to interact with the atmosphere and waterbodies (Vitousek, Mooney, Lubchenco, *et al*. 1997). This leads to drastic alterations in the ecological cycles of urban areas.

Urban forests are valuable ecosystems that provide many services – regulation, provision, cultural, and support – that are beneficial to humanity (MEA 2005). In their work, Pandey and Misra (2016) stress upon the debilitating effects of anthropogenic interventions that cause rapid transformation of forested land cover. This has become a major concern for sustainable management of natural resources. The resultant degraded lands manifest reduced capacity to supply the direct and indirect use values as provided by the ecosystem services. This research from secondary sources argues that to control

the growing pressure on the natural resources, especially the forested land cover, a realistic assessment based on an empirical approach could be the only solution. The involvement of various stakeholders and exhaustive community participation in policymaking could pave the way towards rejuvenated forests, which may lead to sustainable ecological systems.



» **Figure 1:** Top five countries for forest area (million ha), 2020 (FAO 2020)

Present Status of Forest Resources

the land surface covered with forests is fluctuating drastically due to land use changes. As per FAO's *Global Forest Resources Assessment 2020*, the world's total forest area has remained only 31% of the total land area (Table 1). More than half (54%) of the world's forests is in only five countries – the Russian Federation, Brazil, Canada, the United States of America, and China (Figure 1). India is among the top 10 forested countries of the world (Table 2). As per ISFR 2019 report, the total forest cover in India was 21.67% of the country's total geographical area.

Table 1: Forest area by region and subregion, 2020 (FAO 2020)

Region/subregion	Forest area	
	1000 ha	% of world forest area
Eastern and Southern Africa	295,778	7
Northern Africa	35,151	1
Western and Central Africa	305,710	8
Total Africa	636,639	16
East Asia	271,403	7
South and Southeast Asia	296,047	7
Western and Central Asia	55,237	1
Total Asia	622,687	15
Europe excl. Russian Federation	202,150	5
Total Europe	101,7461	25
Caribbean	7889	0
Central America	22,404	1
North America	722,417	18
Total North and Central America	752,710	19
Total Oceania	185,248	5
Total South America	844,186	21
WORLD	4,058,931	100

Table 2: Top 10 countries for forest area, 2020 (FAO 2020)

Ranking	Country	Forest area	
		1000 ha	% of world forest area
1	Russian Federation	815,312	20
2	Brazil	496,620	12
3	Canada	346,928	9
4	United States of America	309,795	8
5	China	219,978	5
6	Australia	134,005	3
7	Democratic Republic of the Congo	126,155	3
8	Indonesia	92,133	2
9	Peru	72,330	2
10	India	72,160	2

The management of forests has been a primary concern for India since ancient times. At the beginning of the 20th century, about 30% land in India was occupied by forests, which eventually declined to 20.55% by the end of the century (Pandey and Misra 2016). By 1997, the country's dense forest cover decreased drastically due to large-scale changes in land use and conversion of forest land for agricultural practices. Therefore, India's National Forest Policy, 1988 aims to increase the forest cover to 33% of the country's total land area to overcome this alarming situation. In this regard, community participation has been considered

the most crucial aspect to ensure protection, conservation, and development of forests in India's National Forest Policy, 1988 and Forest (Conservation) Act, 1980.

Cultural Ecosystem Services and Urban Forests

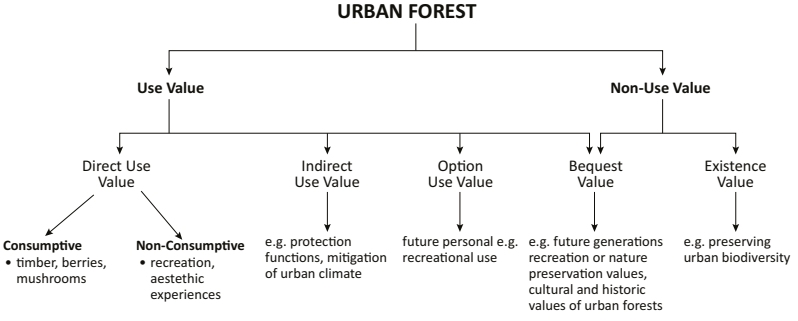
Urban forests in highly dense metropolitan cities have environmental benefits and ensure recreational opportunities for inhabitants to recover from their daily stresses and enjoy a better quality of life. These forest areas improve human well-being and functioning of society (Hanson and Frank 2016). The discourse on cultural ecosystem services (CES) focuses on managing the earth's ecosystems to ensure their conservation and sustainable use. The inter-relationships of ecosystems, the goods and services provided by them, and the benefits that people gain have been internationally assessed in the Millennium Ecosystem Assessment (MEA 2005). The emerging concept of ecological economics describes that "economics and sustainability share an intimate relationship" (Singh, Gupta, and Singh 2006). The alteration and degradation of ecosystems and their ability to provide goods and services would pose negative consequences and incur financial losses. Within the scope of environmental economics, a specific taxonomy of values related to natural resources has been developed, although definitions of these values seem to be either unclear or overlapping (Turner and Meyer 1996). Tyrväinen, Pauleit, Seeland, et al. (2005) classified the values attached to environmental goods and services as use values and non-use values (Figure 2).

Munasinghe (2000) explains, "The direct use value is determined by the contribution an environmental asset makes to the current consumption." The cultural ecosystem services (CES), divided into the categories of cultural diversity, spiritual and religion, educational and aesthetic experiences, inspiration, social relations, sense of place and recreation, are the non-consumptive direct use values that are derived from urban forests (Figures 3 to 6).

Cultural Services for Decision-Making

Natural and protected green areas, especially urban forests in major Indian metropolitan cities, contribute to a captivating green cityscape, and at the same time, communicate the importance of a nature-oriented city. The undervaluation of ecosystem goods and services provided by forests has led to their unsustainable management and is a major cause of biodiversity extinction (Lette and de Boo 2002). The assessment of these intangible benefits faces several methodological challenges as it largely depends on the cultural values of local people and their preferences for wilderness, pleasant landscape, and potential recreational opportunities (García-Díez, García-Llorente, and González 2020; Kwak, Yoo, and Han 2003). Recreational activities in forest areas demand specific infrastructure such as pathways for walking, cycling tracks, physical fitness trails, *machan* (platform erected in a tree, used originally for hunting large animals and now for watching animals in wildlife reserves) for birdwatching and adequate space for passive activities that incur different costs. Kleiber (2001) argues that the assessment of these costs is done by forest managements, but the visitor's benefits have not been evaluated yet.

When conservation competes with conversion, conversion wins because it has market value, whereas conservation values appear to be either low or zero (Pearce 2001). In order to assist decision-making, policymakers make choices between alternatives on the basis of values attached to them. Perhaps, the most significant factor is that a few forest ecosystem services like provisioning have clearly established monetary values as per market-based mechanisms, while the other intangible benefits of CES in urban



» **Figure 2:** Total economic value of urban forests (Tyrväinen, Pauleit, Seeland, et al. 2005, adapted from Turner and Meyer 1996)

» **Figure 3:** City forest trails being used by daily users for walking and jogging

» **Figure 4:** City forests are a source of social interaction in urban societies

forests are often not included in valuation studies. On that account, it becomes important to involve relevant stakeholders to determine the value of functions performed by these natural resources. Having understood the criticalities in the domain area, it is imperative to mention that in a country like India, the relevance of this discussion becomes extremely important.

The Way Forward

Urban forests have multiple benefits, yet the severity of the issue of conversion and deforestation needs a much more holistic, realistic, and goal-oriented approach. The secondary research presented in this article clearly suggests the need to understand and acknowledge the use and non-use values associated with forest ecosystems. The way to realize this idea practically is to integrate these efforts with an empirical assessment of the resource value to clearly bring forward the extent of loss that we are suffering today. Attempts have been made to estimate the direct use values of nature areas which are consumptive but the domain of non-consumptive use values still remains largely unexplored. Also, the aspect of sociocultural ecosystem services needs to be understood in depth and the association in terms of how the use values vary with changing socio-economic settings could be of interest and importance to the planners and policymakers. This finding may further help in defining the programme for these city forests by specifically addressing the requirements of city dwellers and especially the population of the catchment areas. Therefore, the way forward is in the empirical assessment of sociocultural values of cultural ecosystem services.

» **Figure 5:** Urban forests provide opportunities for active recreation

» **Figure 6:** Aesthetic experiences could be gained from visual frames in urban forests

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GRIHA PROJECT'S UPDA T

10% Additional FAR for GRIHA 4/5 rated projects

Himachal Pradesh

Jammu & Kashmir

Upto **15%** FAR benefits for GRIHA certified projects.

Exemption from Environmental Clearance for GRIHA projects

MoHUA gives **1%** to **5%** extra ground coverage and FAR for projects of more than 3,000 m^2 plot size on the basis of GRIHA evaluation

Delhi

Punjab

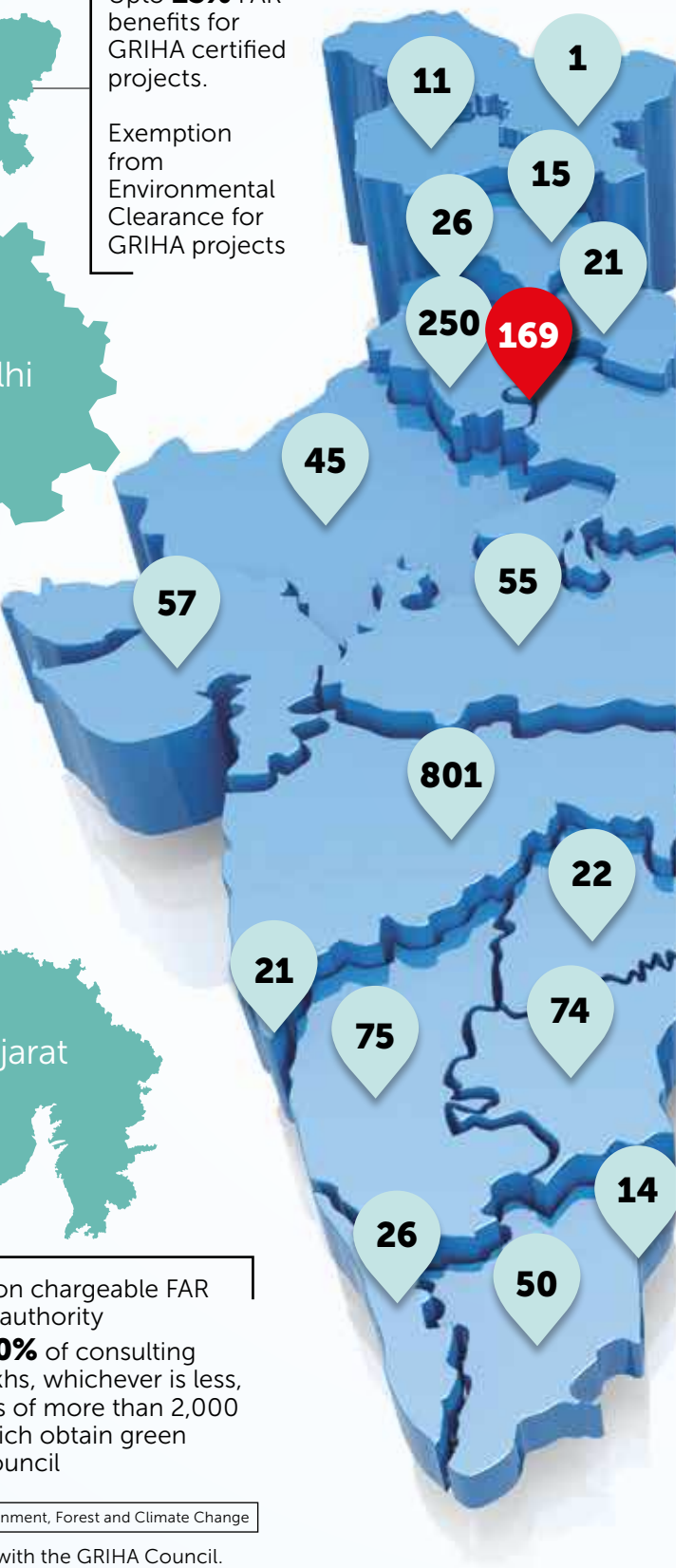
5% Additional FAR for 4/5 star GRIHA rated projects

Haryana

Upto **15%** extra FAR for all building uses (except plotted residence) for all GRIHA variants

Rajasthan

Gujarat



- Buildings having GRIHA rating certificate will be eligible for an additional **7.5%** to **15%** Floor Area Ratio (FAR) free of charge

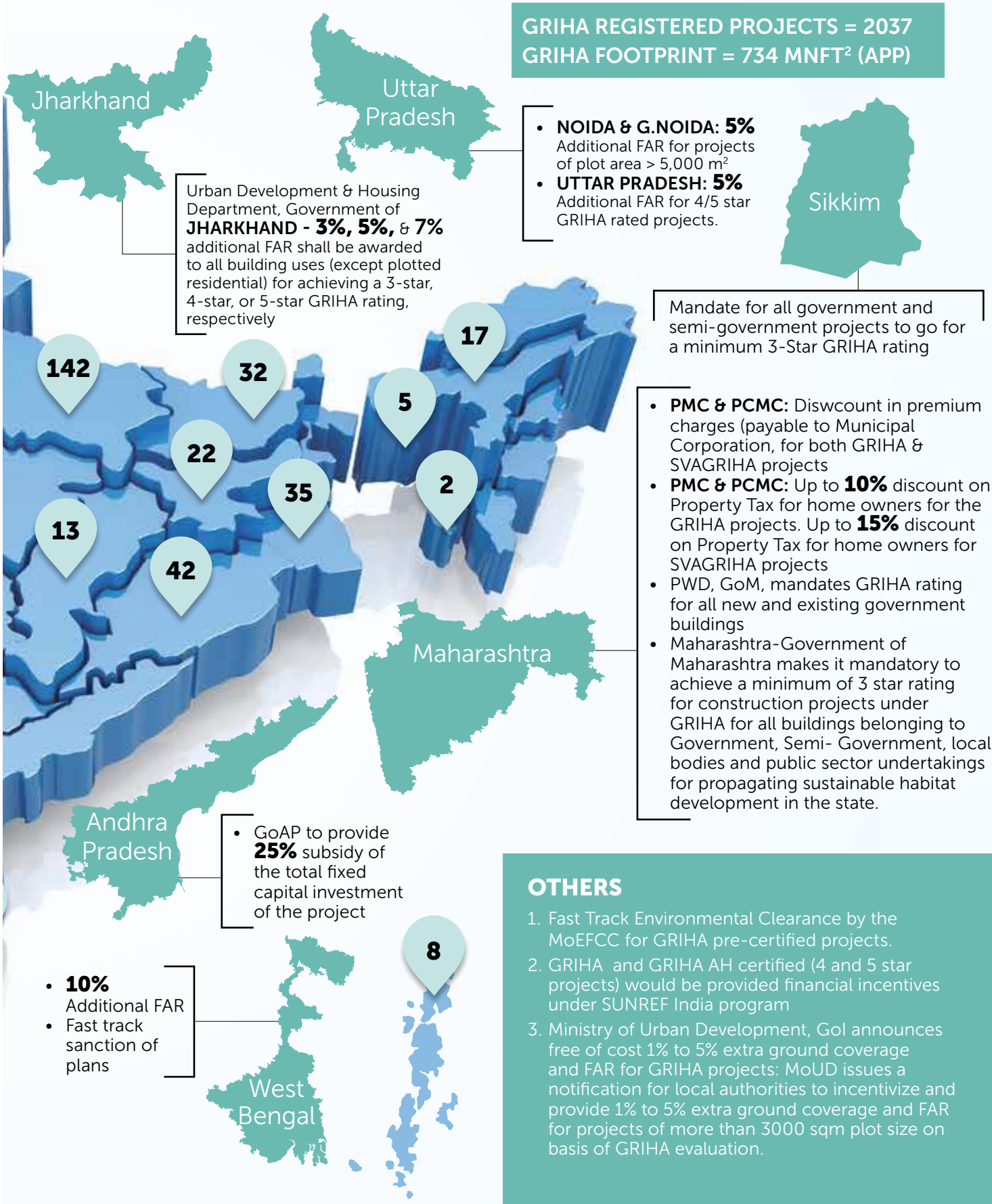
- AUDA: **5%** Discount on chargeable FAR payable to approving authority
- Assistance of up to **50%** of consulting charges or INR 2.5 lakhs, whichever is less, for industrial buildings of more than 2,000 sq.m built up area which obtain green rating from GRIHA Council

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

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

TE & LINKED INCENTIVES

GRIHA REGISTERED PROJECTS = 2037
GRIHA FOOTPRINT = 734 MNFT² (APP)



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

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

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

- **PMC & PCMC:** Diswcount in premium charges (payable to Municipal Corporation, for both GRIHA & SVAGRIHA projects
- **PMC & PCMC:** Up to **10%** discount on Property Tax for home owners for the GRIHA projects. Up to **15%** discount on Property Tax for home owners for SVAGRIHA projects
- PWD, GoM, mandates GRIHA rating for all new and existing government buildings
- Maharashtra-Government of Maharashtra makes it mandatory to achieve a minimum of 3 star rating for construction projects under GRIHA for all buildings belonging to Government, Semi- Government, local bodies and public sector undertakings for propagating sustainable habitat development in the state.

- GoAP to provide **25%** subsidy of the total fixed capital investment of the project

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

OTHERS

1. Fast Track Environmental Clearance by the MoEFCC for GRIHA pre-certified projects.
2. GRIHA and GRIHA AH certified (4 and 5 star projects) would be provided financial incentives under SUNREF India program
3. Ministry of Urban Development, GoI announces free of cost 1% to 5% extra ground coverage and FAR for GRIHA projects: MoUD issues a notification for local authorities to incentivize and provide 1% to 5% extra ground coverage and FAR for projects of more than 3000 sqm plot size on basis of GRIHA evaluation.

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Production of Electrical Power and Vegetables in Desert Land of Ballia

In this article, **Prof. G N Tiwari, Dr Vineet Saini**, and **Dr Arvind Tiwari** discuss the relevance of the concept of a greenhouse-integrated semi-transparent photovoltaic thermal (GiSPVT) system for off-grid power generation and off-season vegetable production in the desert land of Ballia in Uttar Pradesh. Will such a system help ensure ecological sustainability? Read on to find out.

Professor G N Tiwari, President, Bag Energy Research Society (BERS), is among the world's top two per cent scientists from India. An alumnus of Stanford University, USA, he was the co-recipient of the prestigious Hariom Ashram Prerit S. S. Bhatnagar Award in 1982 and the Vigyan Ratna Award by the Council of Science & Technology (CST) in 2007. He has published over 650 research papers, 20 books, and has mentored more than 100 PhD scholars. Presently, he is overseeing GiSPVT-related projects.

Dr Vineet Saini, Scientist 'F', Department of Science and Technology, Government of India has 27 years of experience in developing and executing projects in the energy and water sectors of India and overseas. Within the paradigm of decarbonization, he is instrumental in translational research of clean energy innovation and deployment of low-emission technologies by developing R&D opportunities and guiding field interventions.

Dr Arvind Tiwari, a PhD holder from IIT Delhi, has an experience of over 18 years in academia in both India and abroad. He has a keen interest in hybrid PV thermal systems. As a coordinator, he liaises with Jananayak Chandrashekhar University (JNCU), Ballia, skill development councils, research organizations, and corporate sectors for rural development.

Introduction

This article discusses the field intervention through which an attempt was made to utilize a desert (unfertilized) land in district Ballia in Uttar Pradesh for electrical power generation and production of vegetables to sustain the environment and mitigate climate change risks by using the concept of a greenhouse-integrated semi-transparent photovoltaic thermal (GiSPVT) system. The electrical energy produced was used to maintain the temperature and other parameters for vegetable production. Additionally, it provided the base for microgrid in remote areas where electrical energy was either scarce or of low power quality being supplied to nearby homes, schools, and villages.

The Question of Sustenance

In the aftermath of World War II, rapid industrialization, rising population, and humanity's extreme reliance on fossil fuels led to serious consequences for the environment. CO_2 levels and the overall global air temperature increased significantly, thereby making the survival of human beings difficult. Most of the developing and under-developing countries are now encouraging the use of renewable energy sources to meet their energy demands in order to sustain the CO_2 levels in the atmosphere and climate (Tiwari and Mishra 2011).

As we all know, one primary source of renewable energy is the sun. Solar energy can be used as thermal energy as well as electrical power in semi-transparent photovoltaic (PV) modules (Tiwari, Tiwari, and Shyam 2016). There are two types of PV modules, namely, opaque (Tedlar as base) and semi-transparent (glass as base). The semi-transparent PV modules have a higher efficiency with more applications than opaque PV modules due to the overall energy of the system (Tiwari and Dubey 2010). If the semi-transparent PV modules are integrated to a greenhouse roof, then it is called a greenhouse-integrated semi-transparent photovoltaic thermal (GiSPVT) system (Tiwari 2003). A GiSPVT system can provide electrical power in addition to sunlight through the non-packing area[1] for photosynthesis of plants and thermal energy to maintain the air temperature of the greenhouse.

[1] The packing area of solar cells in a PV module refers to the area of the module that is covered with solar cells compared to that which is blank. In this context, the black spaces indicate the non-packing area.

Greenhouse-Integrated Semi-Transparent Photovoltaic Thermal System

The project on the greenhouse integrated semi-transparent photovoltaic thermal (GiSPVT) system was sanctioned under the Mission Innovation (MI) programme for off-grid electrical power generation of 30 kWp for different packing factors so that the level of the transmitted solar radiation could be investigated on plants in a more scientific manner. In its initial phase, the GiSPVT system, with an effective area of 24.4 m 36.6 m, was installed in a desert land at Margupur, Chilkahar, and Ballia districts for off-grid power generation and off-season vegetable production. This facility could be further utilized for similar field

experiments. Another advantage of GiSPVT is that it helps protect the vegetable production against harsh weather conditions. Figure 1 shows the field demonstration of three rated capacities of PV modules – 80 Wp, 50 Wp, and 25 Wp – installed on the south roof of the greenhouse with a rated capacity of 10 kWp for each category.

For experimentation, the team decided to grow vegetables in a brick channel as well as in a pot to conserve water and encourage organic farming in four different zones inside the GiSPVT system amid desert soil conditions as shown in Figure 2. Six crops – bottle gourd, capsicum, cucumber, French beans, tomatoes, and broccoli – were selected to draw a comparison between different zones with various packing factors of semi-transparent PV modules.

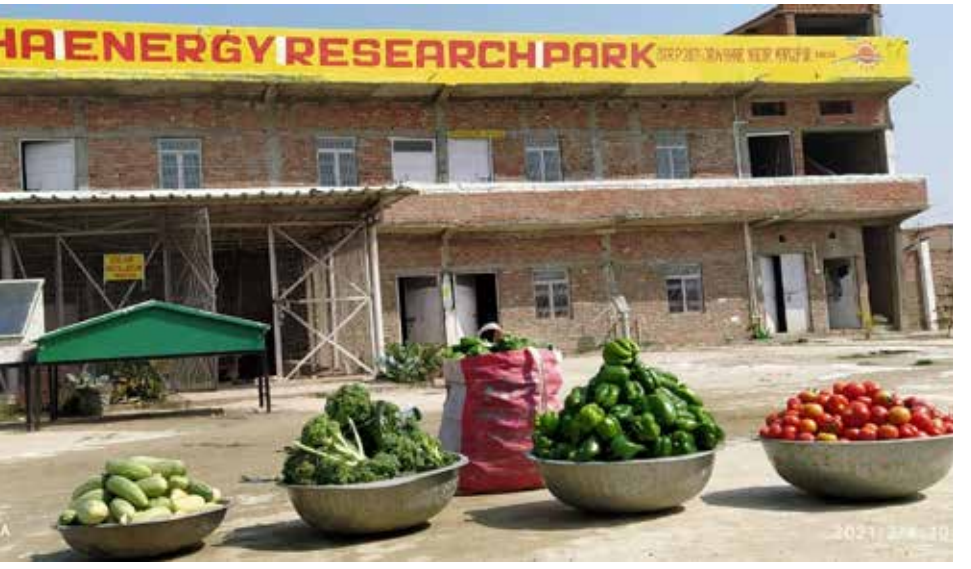
The sowing and transplantation of six vegetables were done during the last week of September 2020 till the second week of October 2021 in root media, prepared in the ratio of 40:40:20 for good soil, sand, and organic fertilizer (cow dung manure). It was completed six months in advance for the stabilization of root media for the higher production of vegetables. Manual watering of the plants (at regular intervals) in both the brick channel and the pot was mandatory to avoid the overflowing of water. Though the levels of CO_2 inside the GiSPVT were sufficient during the seedling stage/ transplantation, they could not ensure the full growth of the plants. Therefore, an arrangement was made by either burning biomass (cow dung cake) at adequate intervals inside the GiSPVT or opening the sliding glass window during peak sunshine hours. This is needed especially when the leaves of the plants start yellowing.

It was observed that there should be sufficient sunlight for each vegetable or plant through the non-packing area of PV modules/light by the self-solar power system inside the GiSPVT for proper photosynthesis to make the system self-sustaining. For uniform availability of light, two 100 W light fixtures were installed in the north wall to sustain the process of photosynthesis in the zones along the north wall.

Results and Discussion

Production of vegetables

The complete cycle of the previously discussed experiments was done between September 2020 and March 2021. During this period, an inside greenhouse air temperature was always observed to be higher by 5°C-6°C till morning in comparison with the outside ambient air temperature. During noon, it would go up to 35°C-36°C when the outside temperature was about 20°C in a sunny condition. Even in very cloudy conditions, the inside greenhouse temperature was always higher due to the release of thermal energy from both the ground surface and the brick channel. It is also important to mention that the air temperature in the greenhouse room varied between 1°C and 2°C due to connectivity issues between various zones. Further, the relative humidity inside the GiSPVT system was found to be maximum (about 90%) during early mornings and late evenings when compared to noon time (75%), which



helped in cooling the plants as well as the semi-transparent PV modules to optimize their efficiency. There was a variation of solar intensity between 108 W/m² and 318 W/m² from zone I to zone IV during clear sky conditions due to different packing factors of semi-transparent PV modules in comparison with the outside solar intensity of 640 W/m² in December. In cloudy conditions during January, only diffused radiation of 10–40 W/m² was observed but the greenhouse air temperature was maintained due to the underground earth energy.

Based on the average production of different vegetables, the yield per *beegha* (2700 ft²) between October 2020 and February 2021 was as follows (Figure 3):

French beans = 708 kg;
Bottle gourd (Lauki) = 1.8 tonne;
Tomato = 4.8 tonne;
Capsicum = 2.6 tonne;
Broccoli = 2.15 tonne; and
Cucumber = 700 kg.

The cultivation was carried out beyond February 2021, but it was observed that only the capsicum production was beneficial due to late sowing while other crops' cultivation was not quite economical.

The experiment concluded that the proposed greenhouse integrated semi-transparent photo-voltaic thermal (GiSPVT) system was uniquely self-sustaining and environment-friendly. It did not need any fossil fuel base grid power or inorganic manure for the production of vegetables.

Electrical power production

During the experiment carried out from September 2020 to March 2021, the GiSPVT system produced electricity of 15,624 kWh. The system produced the lowest electrical energy of 1062 kWh during January 2021 due to less solar radiation reaching the solar panel owing to cloudy and foggy weather conditions for most part of the month (24 days). The maximum electrical energy of 3254 kWh was produced in October 2020 as the weather condition remained sunny for about 25 days.

The overall electrical energy produced by the system was 30,482 kWh for the period July 2020–June 2021 for 208 clear days. The electrical energy produced would have been significantly higher (~38,000 kWh) had the average clear sunny days in India been considered, which was about 300 days, thereby ensuring the system's better economic viability.

Conclusion

- The GiSPVT system utilizes barren/desert land to produce off-season vegetables.
- The GiSPVT system produces electrical energy which can be utilized for maintaining the temperature and other parameters for vegetable production.
- The GiSPVT system can be the base for microgrid in remote areas and charging of e-rickshaws where electrical energy is either scarce or the power quality is poor.
- The electrical power produced can be supplied to nearby homes, schools or villages.

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Green Jobs for Green Growth

Sustainability is the need of the hour to combat climate change. It is essential to strengthen the green jobs sector and create a workforce that will help India achieve higher energy efficiency and accomplish its RE targets. Through this piece, **Dr Parveen Dhamija** highlights how green jobs could be instrumental in envisioning a decarbonized future.

Dr Parveen Dhamija is Advisor at Skill Council for Green Jobs, New Delhi and promotes skill development in various sectors of renewable energy and environmental sustainability. In 2016, she retired as Scientist 'G' / Advisor from the Ministry of New and Renewable Energy after serving for about three decades. She was a coordinator for various programmes such as National Biogas and Manure Management Programme (NBMMP), Improved Chulhas, Women and Renewable Energy Development Village Energy Security through biomass and was involved in the development and promotion of new technologies such as fuel cells hydrogen energy, battery-operated vehicles, geothermal energy, and tidal energy. She has co-authored books on environmental education and has been an IPCC expert in Bio-Energy for the Special Report on Renewable Energy Sources and Climate Change Mitigation, prepared by IPCC and released in May 2011.

What Are Green Jobs?

Green jobs contribute to the preservation of the environment. As per the United Nations Environment Programme (UNEP), green jobs are positions in agriculture, manufacturing, R&D, administrative, and service activities aimed at substantially preserving or restoring environmental quality. International Labour Organization (ILO) has described green jobs as those types of jobs which increase efficient consumption of energy and raw materials, limit greenhouse gas emissions,

Thousand jobs	World	China	Brazil	India	United States	European Union[m]
Solar photovoltaic	3 755[e]	2 214	43	204[h]	240	127
Liquid biofuels	2 475	51	839[g]	35	297[i]	239
Hydropower[a]	1 957	561	213	367	22[j]	78
Wind energy	1 165	518	19	63	120	292
Solar heating/ cooling	823	670	44	23.8	5	36[n]
Solid biomass[b,c]	764	188		58	51[k]	392
Biogas	342	145		85	7	75
Geothermal energy[b,d]	99.4	3			9[l]	40.6[d]
CSP	29.5	11			5	
Total	11 459[f]	4 361	1 158	824	756	1 317[f]

» **Figure 1:** Estimated direct and indirect jobs in renewable energy (2018–19) (*Source: Renewable Energy and Jobs Annual Review 2020, IRENA*)

minimize waste and contamination, protect and restore ecosystems, and contribute to adaptation to climate change. Green jobs are created by the transition to a decarbonized economy which involves changes in production processes and energy use through environment-friendly technologies. This transition will lead to an extensive use of renewable energy and help achieve high energy efficiency in different sectors.

Women in the Green Sector

As per the Renewable Energy and Jobs Annual Review 2020 by International Renewable Energy Agency (IRENA), there is an increase in employment in the renewable energy (RE) sector worldwide with women holding 32% of these jobs (Figure 1). While the solar PV industry continues to retain the top spot, off-grid decentralized renewables are creating a growing number of jobs in areas of agro-processing, healthcare, communications, and commerce for local communities. Employment has also increased in biofuels and there is significant workforce in wind and hydropower projects too. In India, many direct and indirect jobs have been created in the RE sector with women holding 25% of these jobs in decentralized renewable energy (DRE). The need for strong policy frameworks for renewables has been reinforced by the ongoing COVID-19 pandemic with the creation of a large skill base for more training and increased use of information and communications technology for remote learning.

Objectives of SCGJ

The nationally determined contributions (NDCs) push the country to work towards a low carbon emission pathway while creating promising opportunities for green businesses. In October 2015, Skill Council for Green Jobs (SCGJ) was created as part of the Skill India Mission to address the skilled workforce requirement of the green business industry (Figure 2). It acts as a bridge between the government, industry, and various key stakeholders for developing strategies and implementing programmes for skill development that are correlated to industry needs while being aligned to best international practices in the green sector. Its activities are linked to the Skill India Mission, National Solar Mission, Swachh Bharat Mission, and Green India Mission. SCGJ has established strategic alliances with about 400 industries, organizations, and state skill missions. Presently, SCGJ focuses on 'entrepreneurship development for sustainable development' and encourages women to learn marketable skills and get suitable job opportunities.

The main objectives of SCGJ are to undertake skill gap studies and training need analysis (TNA) of

» **Figure 2:** Sectors covered under green business

» **Figure 3:** National Skills Qualification Framework

its sectors, create occupational standards, develop competency frameworks, conduct training programmes, affiliate vocational training institutes, and most importantly, assess and certify trainees on the curriculum aligned to the National Occupational Standards (NOSs). SCGJ develops sector-specific competencies/skills, assures quality of the skills acquired by trainees, develops curriculum, prepares qualification framework and ensures setting of standards and benchmarks, organizes recruitment and placement of trained and skilled workforce, as well as facilitates data collection, management, and providers to the green industry. SCGJ enables the development of a skilled workforce aligned to the National Skills Qualification Framework (NSQF) (Figure 3).

As part of its objectives, SCGJ carries out sector analysis, skill gap studies, occupational mapping, and process flow along with the identification of job roles in different sectors of renewable energy, waste management, and sustainable development (Figure 4).

As per the sectoral analysis on wind and solar energy, India is

Through Ernst and Young in 2016 and revised in 2018

- Solar Photovoltaics
- Solar Thermal
- Wind Energy
- Small Hydro Energy

Through KPMG in 2017

- Solid Waste Management
- Water Management
- Green Construction
- Carbon Sinks
- Clean Cooking

SCGJ & UMC, July, 2018

- Feacal Sludge & Septage Management Skill Gap Assessment Study

SCGJ, CEEW, and NRDC, June 2017

- Greening India's workforce

SCGJ, CEEW, and NRDC

- Powering jobs Growth with Green Energy

SCGJ and FCDO, UK

- Job Roles in O & M of Bio-CNG Plants

SCGJ

- Impact Assessment Report for Suryamitra Training Program

SCGJ, CEEW, and NRDC

- Creating Jobs and Income: Solar Mini Grids making difference in Rural India, Case Study

SCGJ, CEEW, and NRDC

- Employment Potential of Energing Renewable Energy Technologies, Insights from The Floating Solar Sector

» **Figure 4:** Sectoral studies

on its way to achieve its target of 100 GW of installed solar energy and 60 GW of wind energy by 2022. Given the employment generation potential of solar in India, a huge workforce must be trained in skills for manufacturing, engineering, procurement, construction, installation, and O&M (operations and maintenance) to support the market. Thus, in line with India's National Mission on Solar Energy and in consultation with industries and the National Institute of Solar Energy (NISE), 14 NSQFs aligned with Qualification Packs (QPs) were developed for various green jobs. In the wind sector, eight QPs

were prepared in consultation with stakeholders and Chennai's National Institute of Wind Energy (NIWE), for capacity building in resource assessment, development of infrastructure, installation, and O&M of wind electric generators.

In the rural waste sector, there is an urgent need to create a cadre of skilled manpower and local entrepreneurs that would not only manage the surplus agricultural residue but also develop avenues for livelihood generation in villages. A total of four QPs were developed for job roles in the biomass supply chain for managing agricultural residue to reduce stubble burning and create opportunities in the existing and upcoming bio-CNG plants. Indoor air pollution from the use of biomass is also a grave concern and must be addressed. In line with the SDGs, training modules have been designed in a way that job roles could be created in areas of installation, assemblage, distribution and sales, and maintenance of improved cookstoves developed for the clean cooking sector.

In the urban solid waste management sector, Solid Waste Management Rules, 2016, have given an impetus to activities in waste processing and management leading to a widespread creation of employment in waste collection, segregation, transport, processing, and disposal through technologies such as waste-to-energy, biomethanation, pyrolysis and composting, and other solid waste recycling techniques. With regard to the Swachh Bharat Mission, five QPs were developed for different job roles covering the skilling and training requirement of workers in the management of solid waste, faecal sludge, and septage. A recent wastewater management sector analysis revealed the need to skill and train the workforce deployed for the operation of wastewater treatment plants to improve energy efficiency and ensure environmental compliance to health and safety measures of the workers.

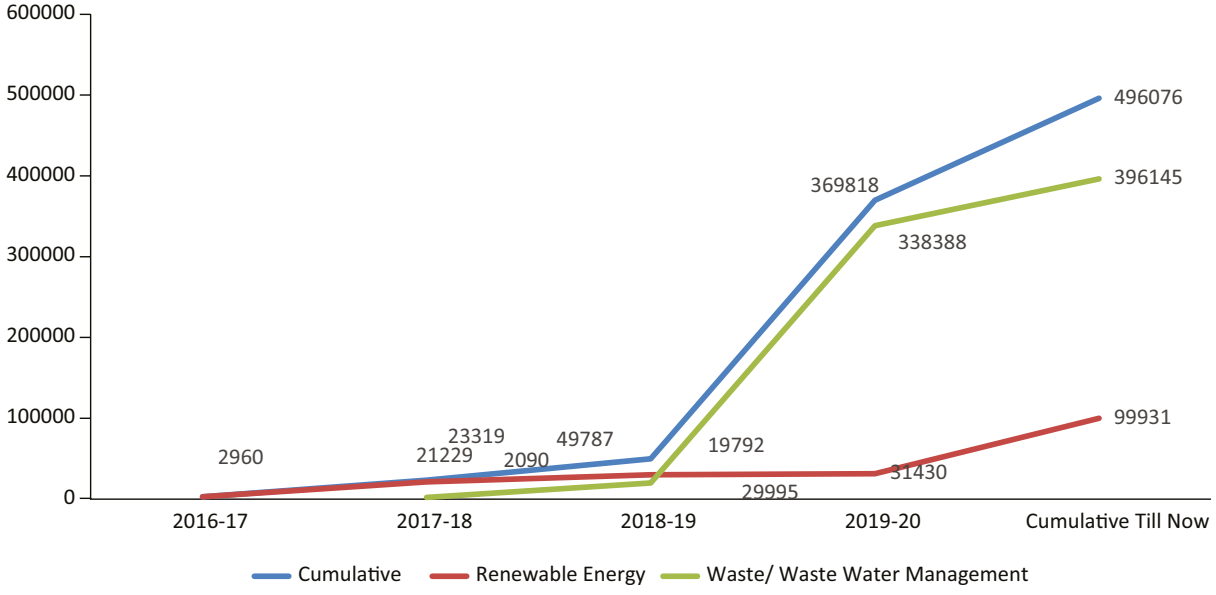
Based on the sectoral analysis, SCGJ developed 51 QPs which included 33 registered qualifications on the National Qualification Register (NQR). In a short span, SCGJ affiliated over 500 training institutions across 24 states in India and organized over 400,000 training programmes on QPs. Over 2000 aspirants were trained by SCGJ and more than 200 assessors certified (Figure 5).

Till now, SCGJ has trained around 99,931 candidates in RE including 78,500 trainees on Solar PV Installer (Suryamitra) through various institutions. As per the impact assessment study, the estimated placement/improvement in job prospects is more than 80% (Figure 6). In the waste management

» (a) Safai Karamchari (b) Septic Tank Technician (c) Desludging Operator (d) Solar Power Plant Installation (e) Wastewater Plant Technician (f) International Training on Solar Power

» **Figure 5:** Skilling and training strategy

sector, about three lakh safai karamcharis and 2500 waste-pickers of municipal corporations in 18 states were trained for mechanized cleaning, segregation, collection, and composting of waste. Under an awareness-cum-sensitization training programme on cleaning of sewers and septic tanks, 3112 desludging workers across 10 states were trained as part of the Safaimitra Suraksha Challenge launched by the Ministry of Housing and Urban Affairs (MoHUA). In Delhi, 793 candidates were trained to be wastewater treatment plant technicians including 118 members from eight common effluent treatment plants (CETPs), who were briefed on O&M and environmental compliance.



» **Figure 6:** Training in green jobs

Building Resilience in Coastal Cities

A Shift in the Socio-Economic Outlook

With frequent storm surges, floods, and damage to coastal areas, a rising sea level is posing a serious threat to humanity around the world. In this article, **Ar. Munawar Irfaan** and **Ar. Sai Patil** foreground the need for long-term commitments which must be matched by immediate actions to launch the decade of transformation that people and the planet so desperately need.

Ar. Munawar Irfaan is an urban designer and architect from the School of Planning and Architecture, New Delhi. He strongly believes in an environmentally sustainable approach towards development that is driven by greener and socially inclusive economic growth. He is passionate about working on urban design projects aimed at improving people's relationship with nature. He can be reached at munawar.irfaan@gmail.com.

Ar. Sai Patil completed her post-graduation in Urban Design from the School of Planning and Architecture, New Delhi. She has worked on a wide spectrum of urban design projects that are driven by ecologically sensitive strategies. Born and brought up in a coastal town, she has a keen interest in exploring the resilience of coastal communities to climate change risks. She can be reached at saipatil1995@gmail.com.

Where Are We Heading?

With an erratic rise in global warming, the world's oceans are now 20 cm higher than they were in 1850, thus, making the rising sea level one of the most disastrous effects of the ongoing climate crisis. Based on sea level projections for 2050, land currently home to 300 million people will fall below the elevation of an average annual coastal flood. By 2100, the land now home to 200 million people could sit permanently below the high tide line (HTL) with consequences ranging from frequent coastal flooding that can damage infrastructure and crops to the permanent shift of coastal communities.

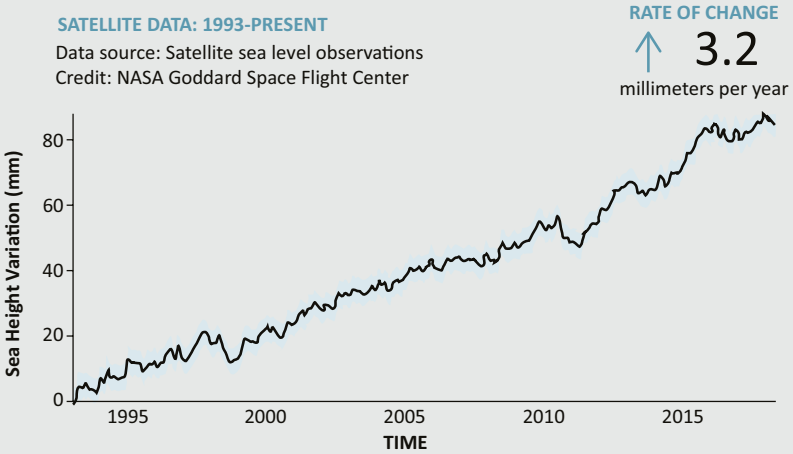
With most of the megacities located along the coastal regions, the impact caused by rising sea levels on the national GDPs could lead to loss of livelihoods, employment, shelter, health, food, and water security. This will cost the world more than 4% of the global economy each year by 2100 unless the coastal communities and their infrastructure are made climate-resilient. As a result, many coastal cities are already planning adaptation measures, often at considerable

cost by building massive concrete seawalls, rethinking roads, and other existing coastal defence measures, which might protect the coastal population against the current sea level rise but may not be adequate for future sea levels (Figure 1).

At the same time, intensive resource use, limited resource endowments, rising energy costs, and the inability of ecosystems to provide critical services are together expanding the environmental, economic, and social vulnerabilities and uncertainties. This means, the current economic strategies which rely heavily on an unlimited supply of free or cheap resources will no longer be possible. Hence, a long-term vision is required in which resilience is fostered by an economy that is in closer alignment with sustainable development objectives – one that meets the development needs while reducing the vulnerability of socio-economic systems to environmental change and resource constraints.

This highlights the need for shifting towards greener growth in which economic progress is fostered by environmentally sustainable, low carbon, and socially inclusive development. Green economy helps in reducing the implications of adverse shocks through various actions, such as economic diversification, resource efficiency, social inclusiveness, ecosystem preservation, and sustainable production and consumption.

While there is no doubt about the negative effects caused by a rising sea level, it is equally important to identify the various opportunities such a scenario could offer. A green economy-driven and context-sensitive adaptation to the rising sea level can substantially increase the investments in economic activities that build on and enhance the earth's natural capital. It provides long-term and locally rooted solutions to address the convergent challenges of ensuring energy, water, food, and environmental security amidst a rapidly changing economic and environmental reality. This can be achieved through community empowerment, knowledge networking, institutional innovations, and sensitive policy formulations.



» **Figure 1:** NASA graph showing the global annual sea level rise
Source: Holtz-Washington (2019)

Energy Self-Sufficiency

With rapid urbanization, many countries are increasingly becoming susceptible to price shocks due to a sharp rise in energy demands. Most of these countries are heavily dependent on fossil fuels to fulfil the major share of their energy demands. Hence, it is necessary to understand the potential to invest in the use of clean energy through effective and climate-resilient systems. The oceanic environment has conventionally provided energy sources, but the overall proportion of global electricity generation from ocean-based sources is just 0.3%. The ocean receives approximately 70% of the available sunlight, and about 90% of the world's wind energy occurs over the ocean. Thus, capturing the ocean's vast potential for renewable energy is the key to achieve energy independence.

New and innovative efforts are being taken to capture the energy embedded in ocean swells in southern Australia. There is a plan of using special buoys (Figure 2) to convert the sea waves into a maximum of 62.5 MW, which is enough to power 10,000 homes. Beyond 'PowerBuoys' in Australia, wave energy proponents are now testing diverse ideas for power generators that can pull double duty for desalination and maritime surveillance.

Integrated Water Resource Management

In certain parts of the world, seasonal water shortages have become more severe in recent years. This is posing

» **Figure 2:** Specially designed buoys using ocean waves to generate energy
Source: Handwerk (2014)

a limit to economic development while affecting food and energy production along with adverse implications on the health and livelihoods of populations. As water scarcity is projected to increase, improving access to reliable and affordable water infrastructure for safe water and sanitation is of greater necessity than ever before. Seawater desalination can deliver a climate-independent source of drinking water as the availability of seawater is not affected by climatic conditions.

Efoetsy (Figure 3) is a remote village located on the dry south-western coast of Madagascar with saline groundwater. Over the years, the region has been affected by water scarcity. To collect water, women, and children of the village had to travel for hours each day until Elemental Water Foundation, a certified NGO, along with local partner Trans-Mad installed a solar-powered desalination plant. Due to their combined efforts along with the local community's involvement in its operation and distribution, about 3000 inhabitants of Efoetsy now have uninterrupted access to safe drinking water.

Sustainable Agriculture

Agricultural intensification, which is being carried out in many places today, may help meet the short-term demands while reducing poverty and hunger, but it might compromise on long-term prospects of meeting food security needs. A more efficient sustainable agriculture that minimizes the negative effects of intensive agriculture will require climate-resilient solutions. Rising sea levels lead to increased seepage of seawater with further inland intrusion. This will, in time, contribute to the ever-increasing salinization of farmland. Adequate countermeasures are the necessity of the hour to prevent the loss of food production capability that causes severe damage to coastal economies.

» Figure 3: Inhabitants of Efoetsy filling water from the solar-powered desalination plant
Source: *Dutch Water Sector (2019)*

Pokkali farming is a technique that has earned exhaustive attention in recent years (Figure 4). Rice experts have initiated studies on its adaptation to saline water. The Agency for the Development of Aquaculture is offering an 80% subsidy for Pokkali cultivation, inspired by the commitments to the Paris Agreement on climate change. Several research institutes including the International Rice Research Institute are studying Pokkali's gene pools. The ability to resist sea erosion and weather floods can make Kerala's indigenous Pokkali rice, the rice of the future (Shaji 2021).

Ecosystem-Based Adaptation

The exploitation of environmental resources in the pursuit of short-term monetary benefits has destroyed our natural environment, specific ecosystems (wetlands, watershed areas, coral reefs, and mangrove forests), and overall biodiversity. However, on a positive note, natural capital investments can, over time, help secure critical ecosystem services such as water regulation and flood control through ecosystem-based adaptation approaches and sustainable infrastructure development. Sea level rise is likely to have a dramatic impact on the low-lying coastal and intertidal habitats through frequent floods and coastal erosion. Hence, living shorelines that use plants or other natural elements, sometimes, in combination with harder shoreline structures become vital in stabilizing the estuarine coasts, bays, and tributaries while also improving water quality and biodiversity.

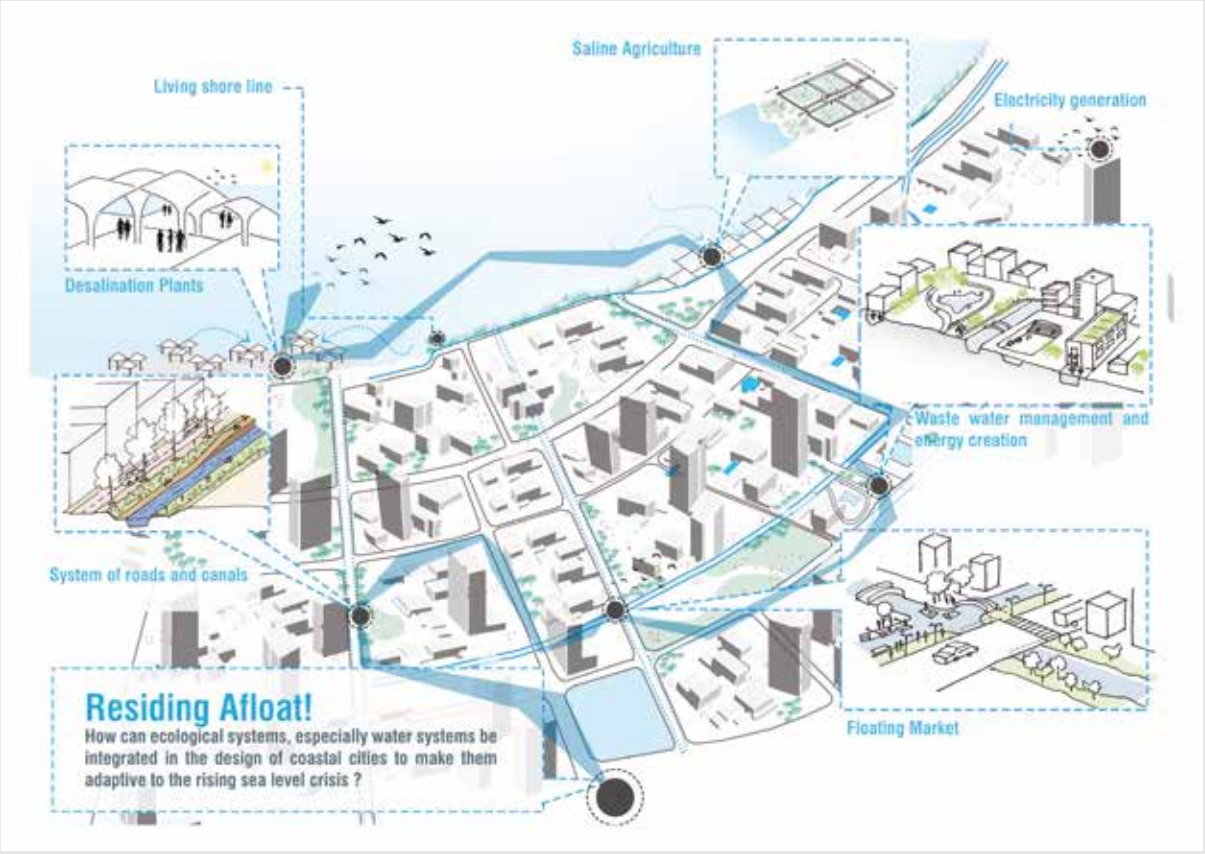
The North Carolina Coastal Federation has been pushing the use and instalment of living shorelines which have taken the form of bags of oyster shells, placed in the water to form reefs (Figure 5). The reefs are then augmented by the planting of seagrasses and other natural and native vegetation. This not only helps in preventing erosion by holding the soil together but also reduces the level of pollution and the bacteria-laden storm water run-off into the estuary.

Conclusion

Currently, due to insufficient climate action and negligence, national economies and the livelihoods of the citizens are becoming increasingly vulnerable to sea level rise. At the same time, population growth, accumulation of wealth in developed countries, and rapid economic progress in developing countries are all contributing to the rising energy consumption rate. Hence, there is a pressing need to make the coastal communities and their infrastructure climate-resilient through green economy-driven strategies which will promote resource-use efficiency, environmental protection, and economic growth while ens uring equitable outcomes for the people. Pursuing green growth will prepare economies and societies, particularly those in developing countries, to face an uncertain and resource-constrained future, while also creating green jobs (Figure 6). Thus, in an ever-changing developmental and environmental context, green growth – defined as economic progress – that fosters environmentally sustainable, low carbon, and socially inclusive development can be viewed as a great economic-and-risk management strategy to strengthen economic, social, and environmental resilience in the future.

» **Figure 4:** Women farmers engaged in Pokkali rice cultivation
Source: *Community Agrobiodiversity Centre (2021)*

» **Figure 5:** Volunteers create an oyster reef off Carteret Community College with bags of oyster shells
Source: *Rich (2015)*



» **Figure 6:** Author's visualization of a climate-resilient coastal city

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Partnerships: An Accelerator to a Sustainable Urban Future

The Case of EU's IURC Programme

In this article, **Prachi Merchant**, **Ansu Alexander**, **Ashish Verma**, and **Dr Panagiotis Karamanos** discuss the European Union programmes on urban and regional cooperation and explain how they serve as partnership instruments through city-to-city diplomacy and collaborative regional efforts to overcome common challenges. The authors specifically highlight the Panaji Smart Parking Project as an example of the global partnership for sustainable development.

Ms Prachi Merchant is an urban planner with more than 20 years of experience in spatial planning, policy preparation, governance, transportation, and social development. In her current role, she is Senior Urban Planner, Mumbai Parking Authority; member of Mumbai's Advisory Committee on Gender and Urban Development; and Manager for the European Union IURC programme in India. She can be reached at pmerchant@iurc.eu.

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Dr Panagiotis Karamanos, a PhD from Indiana University, Bloomington, has more than 20 years of experience in India, Europe, and the US on environmental, urban, and policy issues. In his current role, he is Urban Development Expert for the European Union IURC programme in India, working with cities in India and Europe to adopt best sustainability urban practices. He can be reached at pkaramanos@iurc.eu.

Introduction

The Sustainable Development Goals (SDGs) have guided innumerable city development agendas. To ensure the fulfilment of SDGs, a second level intervention for the city's guidance system is necessary. The merit however lies in actual implementation within the local context. The European Union programmes on urban and regional cooperation (IUC and IURC) serve as partnership instruments through city-to-city diplomacy and collaborative regional efforts to overcome common challenges. For instance, the Panaji Smart Parking Project demonstrates a model of partnership between Indian and European cities for projects of local importance by applying international expertise beneficial for the city's overall development.

Importance of Partnerships

Multistakeholder partnerships have currently become a state-of-the-art word within sustainable development parlance. A partnership is a "formally organized coalition of interests comprising actors of different sectors aiming at joint policymaking and implementation with a common agenda and action programme" (Lang 2005).

The 2030 Agenda and the SDGs call for a collaborative effort to realize the critical needs of our planet. Goal 17 introduces a 'global partnership for development' which requires significant systemic collaboration across societal sectors creating value towards a common goal. It is partnerships at national, sub-national, and city levels that harness and optimize our finite resources to deliver the SDGs and build self-sustaining and resilient nations (Stibbe and Prescott 2020). The Paris Agreement emphasized the importance of a financial, technical building, and capacity partnership between developed and developing nations (UNFCCC n.d.). The New Urban Agenda was introduced at the UN Habitat III Conference to tap the potential of cooperation among cities, businesses, industries, institutions, and civil society as a quadruple helix model to implement the SDGs (IISD–SDG Knowledge Hub 2016).

The SDG vertical under NITI Aayog, the nodal agency for coordinating and monitoring the SDGs in India, works closely with key stakeholders including the government, research and academia, civil society, private sector, and multilateral organizations – to accelerate the fulfilment of SDGs in the country (NITI Aayog n.d.). The Government of India through the Ministry of Housing and Urban Affairs (MoHUA) encourages city-to-city cooperation through its 'Twinning of Cities' where strategic partnerships can be developed between an Indian city and a city/state/province of a foreign country in an effort to exchange information, ideas, technical assistance, and training related to sustainable development (MoHUA 2014). Moreover, India through MoHUA has signed Memorandums of Understanding (MoUs) with various countries and multilateral organizations to further our SDGs.

Partnerships serve as a fertile ground for fostering innovation, encouraging sharing of best practices, developing localized shared solutions, facilitating funding, and augmenting respective

capacities (UNIDO n.d.). Following are indicative examples of MoUs signed between international governments and MoHUA (MoHUA 2021):

1. Special planning, water management, and mobility management with Netherlands
2. Urban regeneration and development with United Kingdom of Great Britain and Northern Ireland
3. Sustainable urban development with France, Germany, and Japan

Figure 1 indicates the partnership benefits in urban growth through administrative reforms.

European Union International Programmes on Urban and Regional Cooperation

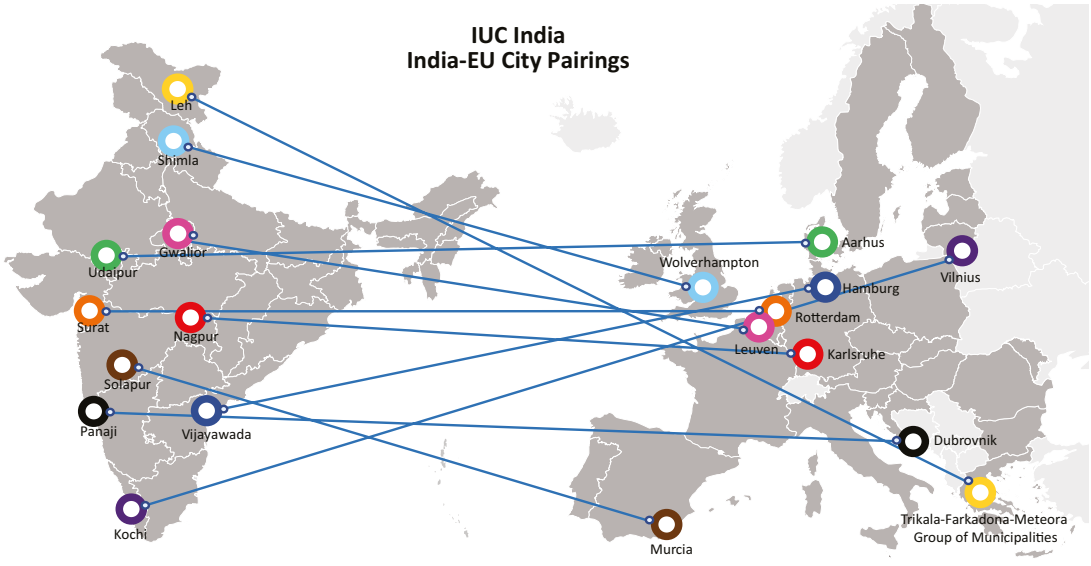
The Urban Agenda for the European Union (EU) is an integrated and a coordinated approach to promote smart, sustainable, and inclusive growth by setting up multilevel and multistakeholder partnerships focusing on policy and regulation, innovative funding, and urban-policy knowledge base (European Commission n.d.). At the UN Habitat III Conference held in 2016, the European Union committed to "foster cooperation between cities across the world to link up with one or more partner cities to develop and implement local action plans and projects on common priorities" (CSR Europe n.d.) through the Urban Agenda. The European SDG Summit in 2020 highlighted the importance of increased impactful partnerships across nations to collaborate towards the realization of a sustainable and inclusive urban development (CSR Europe n.d.).

The European Union International Urban Cooperation (IUC) programme (2016–2021) emerged from a goal to fulfil major international agreements such as Urban Agenda, SDGs, and the Paris Agreement (IUC n.d.). As part of IUC, 10 pairings were developed between the EU and Indian cities, leading to a number of studies, reports, and pilot projects (Figure 2).

The strategic partnerships between some of these cities as well as new cities will continue as part of the follow-up IURC programme, which is being implemented from 2021 to 2023 in cooperation with the Government of India and the EU Delegation in India. IURC targets to develop a decentralized international urban and regional cooperation in sustainable urban development and innovation, with key partner countries in line with 'Europe 2020'. Through the programme, IURC will transform into a "global network of reference for urban and regional innovation by augmenting the impact of international cooperation" (IURC 2020). In the case of India, 10–14 cities are expected to be part of this programme. The topics of cooperation are related to urban planning, mobility, waste management, water management, and heritage protection among others.

The model of city-to-city cooperation on sustainable urban development provides the opportunity for cities to "learn from each other, set ambitious targets, forge lasting partnerships, test new solutions, and boost their international profile" (EU n.d.). These initiatives are aligned with the 2017 Joint Declaration between the EU and the Government of

» **Figure 1:** Benefits of partnership in urban growth
Source(s): *European Commission (n.d.); Friesecke (2007)*



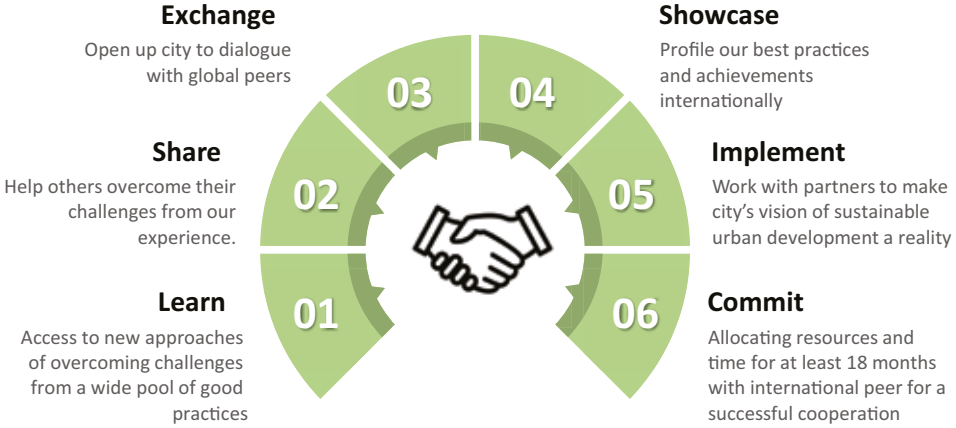
» **Figure 2:** Map indicating pairing of Indian and European cities under IUC project
Source(s): *(EU n.d.); (Survey of India 2020)*

India on 'Partnership for Smart and Sustainable Urbanization' and 'EU–India Strategic Partnership: A Roadmap to 2025'. With EU–Indian city partnerships, the cities benefit in different ways as shown in Figure 3. Similar to IUC, the IURC follows a strategy of local sectoral contextualization by implementing the programme and selecting relevant partners by focusing on their needs and priorities. As a result, it is possible to bring in the right focus, relevance, and improved implementation. A case in point is the successful cooperation between the cities of Panaji, Goa, and Dubrovnik, Croatia on smart parking as part of IUC.

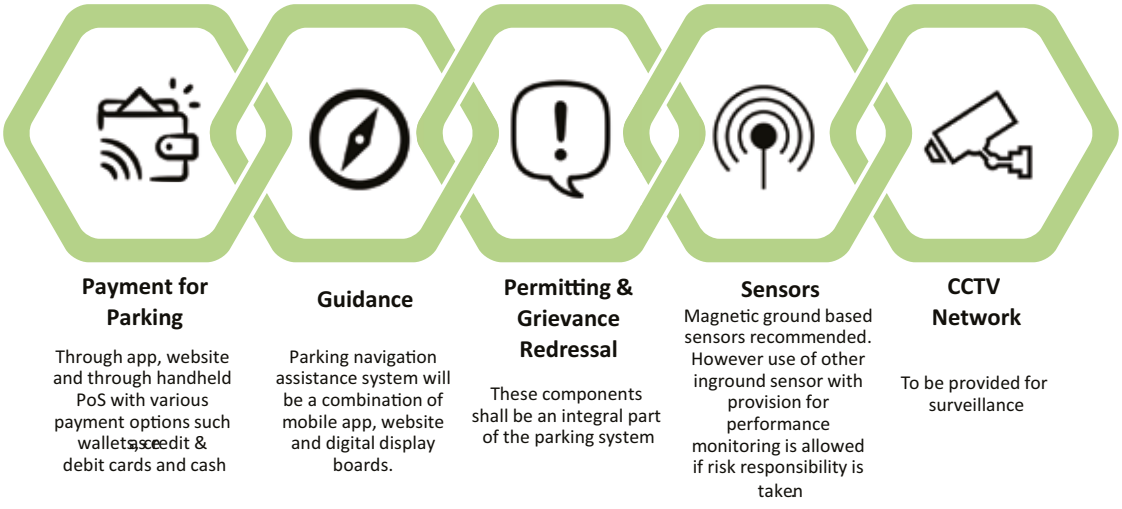
The Case of Panaji Smart Parking

With India's urban population expected to reach 814 million by 2050 (UN 2014), the country is facing an increased demand for mobility followed by other challenges in this sector. Smart mobility has become an increasingly deliberated theme in sustainability agendas in response to the impact of the transportation systems in cities (Munhoz, Dias, Chinelli, et al. 2020).

As part of the IUC programme, several cities such as Panaji, Nagpur, and Gangtok expressed interest to work on challenges related to



» **Figure 3:** Benefits of IURC programme (IURC 2020)



» **Figure 4:** Components of the smart parking solution in Panaji (IUC 2021)

urban mobility and the programme supported them by forging partnerships with European cities and encouraging technical knowledge exchange, capacity building, etc. As a result, these cities are constantly improving their approach to mobility services. The cooperation between Panaji and Dubrovnik is one such example where the model of city-to-city partnership has proved to be successful in showcasing an effective approach to parking.

The selection of Panaji city in the IUC programme was done through a competitive process where a number of factors were evaluated (e.g., challenges, interests). Based on this information, Panaji was paired with Dubrovnik, which had faced similar urban challenges and conditions. The initial interactions, exchange visits, preparation of joint local action plans, pilot projects, and other shared activities allowed the two cities to develop a focused approach and create appropriate solutions (IUC 2020). Through deliberations, a highly congested city centre was selected as the pilot area. The Corporation of the City of Panaji (CCP) in partnership with Dubrovnik city experts agreed to adopt smart parking solutions with specific components, as described in Figure 4. A detailed study was developed for the pilot project (Figure 5). The project aims to improve the traffic flow, mobility, and living conditions. It would further help in getting additional revenue. Smart parking can significantly curb air and noise pollution levels, thus saving time, fuel, energy, and reducing traffic problems. Local businesses would benefit with ease of parking, resulting in greater customer footfall. The next

» **Figure 5:** Map indicating the site for pilot parking project in Panaji, its length and number of parking lots (IUC 2021)

step is to identify financing options for implementing the project.

Conclusion

The SDGs guide the cities at a macro level and depend on the regional and local governments to partner at various levels for their implementation. The partnership governance model is useful for implementation of global programmes, opening doors for interaction, establishing practical linkages between policy and its execution as also for economic, social, and governance benefits. The European Union IUC and IURC approaches fulfil goals at the global, regional, and local levels. A case of Panaji Smart Parking project is developed at a local level along with the partner EU city of Dubrovnik by aligning the SDGs with the National Smart Cities Mission. The city showcases a project useful for the city's overall development and encourages other cities to replicate as well.

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NALANDA UNIVERSITY, RAJGIR, BIHAR

Nalanda University is a postgraduate, research-intensive international university supported by the participating countries of the East Asia Summit. The university was established on 25 November 2010 by a Special Act[1] of the Indian Parliament, and it has been designated as an 'institution of national importance'. Nalanda is inspired by the academic excellence and vision of its predecessors, and it aspires to meet and set global standards of academic brilliance and research while enabling capacity building in all areas of higher learning.

The university is supported by all the member states of the East Asia Summit and to that effect, intergovernmental memorandums of understanding (MoUs) have been signed by 17 countries. Historical sources indicate that Nalanda University had an illustrious life which lasted almost continually for 800 years from the 5th to the 12th century CE. It was a completely residential university believed to have 2000 teachers and 10,000 students. The Nalanda ruins reveal through their architectural components the holistic nature of knowledge that was sought and imparted at this university. It suggests a seamless coexistence between nature and human, and between living and learning. In its present avatar, Nalanda University is envisaged as a campus of the future, positioned at the forefront of global education and hub of scholastic excellence. A sprawling 455-acre campus is being developed to ensure sustainability by promoting green and clean energy solutions while adhering to the guidelines of the ECBC, MNRE, NBC, GRIHA LD, and IEC.

[1] Nalanda University Act, 2010. For more details, visit https://pib.gov.in/PressReleasePage.aspx?PRID=1535318

Prof. Sunaina Singh
Vice Chancellor, Nalanda University

Under the dynamic leadership of Vice Chancellor Prof. Sunaina Singh, Nalanda University has been awarded a '5 Star' rating under GRIHA LD for its master plan and incorporation of an integrated sustainable approach. The project demonstrated a unique approach in its integrated water management through the use of indigenous methods (Ahar pynes on natural gravity) during the construction and post-construction periods. The construction sequence and activities were managed in such a way that the waterbodies were excavated first, and the storm water from the entire site was diverted to rainwater harvesting pits to manage 100% of the storm water on-site.

Since the project did not take any water from the local municipal supply, it aimed to achieve 100% self-sufficiency. The project had adequate water supplies to support 53,168 people on-site when the planned population stood at 16,990. The excavated soil was potentially utilized as per its properties – mud soil for compressed and unburnt bricks; and fertile soil for horticulture purposes. The campus was evaluated on four criteria, which revolved around key sustainability and environment-strengthening aspects of operating a large facility.

The project claimed 19.16% saving over the base case energy consumption as per GRIHA LD benchmark and defined equipment load. The project reduced the overall energy consumption by 62.89% below the GRIHA LD base case. Astronomical timer switches were installed at the project site to control all the outdoor street lights. Smart mini-grids having an integration of various energy sources with prioritization to renewable energy sources (RES), and dynamic balancing of energy supply were proposed in the project. Currently, the smart GRID-SCADA is being implemented for automated system, effective monitoring, supervision, and real-time operations.

Prof. Sunaina Singh's relentless efforts in building and establishing the net zero sustainable green campus are commendable. In its endeavour to realize the net zero vision and mandate, Nalanda University has been able to manage de-touring the cross-country PNG project under the Pradhan Mantri Urja Ganga Pipeline Project. This could happen with the able support from the then Minister for Petroleum and Natural Gas, Shri Dharmendra Pradhan, who, on the Vice Chancellor's appeal, helped the university in de-touring the pipeline work. Presently, the pipeline is being extended from Silao to the university campus, which is an extensive outreach contribution to both society and the local vicinity. With the Vice Chancellor's efforts and timely support from the government, the natural pipeline is now being extended till the residents' places, the kitchens, and laboratory blocks for experimental purposes. The project is committed to treat its 100% generated organic waste on-site. An on-site organic waste composter of capacity 700 kg/day has been proposed, which will be able to treat organic waste of 255 tonne per annum. The construction and development of the campus are being executed by the use of low-impact building materials, construction technologies, and locally available building materials with either high recycled content or standard recommended waste materials such as fly ash.

Though the concept of net zero living is gaining acceptance as a sustainable and valued form of lifestyle in India, achieving this feat is far from easy. We extend our heartfelt gratitude to GRIHA for entrusting us with the role of helping the prestigious institution achieve the status of a net zero campus. The GRIHA Council team has been instrumental in extending their support and guiding our project team throughout the execution and final documentation stages.

Personal Carbon Trading in India

Promoting Low Carbon Behaviour

In this article, **Amruta Khairnar Patil**, and **Prof. V M Chariar** discuss the relevance of low carbon behaviour and implementation of carbon pricing measures to reduce greenhouse gas emissions and combat climate crisis. The authors also highlight the issue of affordability of green products and suggest carbon pricing methods to develop the market for cleaner technologies.

Ms Amruta Khairnar Patil is pursuing her PhD from Indian Institute of Technology, Delhi. She is an architect and urban planner with eight years' experience in sustainable urban practice, regional planning, and rural development. As part of her PhD thesis, she has successfully developed the circular economy framework and aligned technologies for safe sanitation behaviour uptake.

Prof. V M Chariar is an educator, entrepreneur, designer, and coach with more than 25 years of experience in public policy, design of sanitation systems, public health, and rural housing infrastructure. In his current role, he has successfully brought green design to the forefront of ecological sanitation and housing practices. He is also the founder of JoyIsYou and Ekam Eco.

Background

The issue of greenhouse gas (GHG) emissions is a major concern for many developed and developing countries. The detrimental effects of such emissions are most likely to get worse in absence of any vigorous action by both developed and developing nations. India, despite being a developing nation, is the third highest emitter of CO_2 (Le Quéré, Andrew, Canadell, et al. 2016). By 2030, as per the emission projections based on growth in the economy leading to higher energy use, the per capita emissions are expected to increase by 40% (Karstensen and Roy 2020).

Nevertheless, people's inclination towards the available stock of green products is unsatisfactory. The 'personalized information interventions' to raise carbon awareness and improve literacy for making green choices also seem ineffective. Presently, individuals who uptake low carbon behaviour are mainly driven by their emotional appeal for a sustainable future (Matthes and Wonneberger 2014).

As a result, green products seem ineffectual as most of the people make their purchasing decisions based on their rational appeal. They generally opt for products that are easily available and affordable (Joshi and Rahmanb 2015).

Carbon Pricing Measures to Reduce GHG Emissions

As an antidote to the climate crisis, several measures were undertaken at the national level to limit GHG emissions and develop the market for cleaner technologies and green products through various carbon pricing methods such as carbon tax (CT), emissions trading scheme (ETS), and personal carbon trading (PCT). The carbon tax is levied on the carbon emissions required to produce goods and services (Yu 2020). The ETS allows the regulators to set a cap on the aggregate level of pollution permitted in an industrial area, and further lets the industries self-regulate to ensure that pollution does not exceed the decided cap (Bandyopadhyay 2016). PCT transfers the idea of emissions trading to the level of private households. Each household receives an annual GHG budget in the form of GHG certificates. These certificates must be used for GHG-intensive activities (such as air travel). Households that use up their budget must buy certificates from those households that have not used theirs (Fawcett 2010).

The first two approaches of carbon pricing, i.e., CT and ETS, covering 28% of the GHG emissions caused at the corporate and industrial levels, prevail in many countries. The remaining 72% caused by households are noted to be unaffected by CT schemes. The rise in the product price due to energy taxation seems less likely to make a difference in promoting preference for green products (Parag and Fawcett 2014). PCT, which attempts to cover the household energy consumption, responsible for 72% of GHG emissions, has still not been implemented at the national level (Bothner 2021).

Challenges to Adopt PCT

The idea of PCT introduced around 20 years ago, by Fleming and Hillman, is still at the conceptual stage. Nevertheless, there are a few cases where it has been implemented, not at a national or global level but in particular sectors, for example, transportation (Mohamed Omar Al-Guthmy 2021) and cookstove projects (Lambe 2015). To date, despite the wider coverage of the global emissions, PCT could not make it to the national or global policy, unlike CT and ETS. Based on the various researches and reports, the prime reasons for this seem to be lack of support by researchers, practitioners, and most importantly politicians (Bothner 2021), technology for implementation, cost of operation, public ability to deal with parallel currency, and social acceptability (Fawcett and Parag 2010). Moreover, regarding PCT, the equal distribution of allowances is questioned from

philosophical perspectives (Fawcett and Parag 2010). Presently, there are several carbon emissions trading schemes that have been developed to control the household GHG emissions by various countries. The set of such schemes include 'cap and share,' 'tradable energy quotas,' 'tradable consumption quotas,' 'personal carbon allowances,' 'household carbon trading,' and 'tradable transport carbon permits'. Despite the significant theoretical and technical advancement in the PCT scheme, it could not be implemented in national or global policy.

The scope of operation of the aforementioned PCT scheme options, except 'tradable transport carbon permits', is wide as far as the targeted sector is concerned. These are supposed to be operated at the national level targeting the whole economy. 'Tradable transport carbon permits' are executed in the transportation sector and presently, the implementation has resulted in significant carbon reduction. For instance, it can be inferred from Kenya's transportation experience that the successful implementation of PCT albeit in limited scope is achievable. However, the wide scope of the scheme leads to complexities too, thereby making it less feasible for execution.

Key Takeaways

Based on the literature related to PCT, its execution challenges, and the case study of Kenya, the key takeaways with guidelines for the proposed PCT scheme in the Indian context are as follows:

The PCT scheme can be formulated with limited scope initially with respect to the sector where it is going to be implemented and economy, i.e., limited to the household economy or a particular section of the demography such as, farmers, latrine users, or heads of rural households, who are typically the low emitters.

Gradually, the scope can get wider so that other sectors can be included to establish the market for carbon credits. To make the PCT more organic, there should be buyers and suppliers of carbon credits. Initially, carbon credits can be floated to the economy through government subsidies in prime sectors, such as sanitation, housing, and agriculture. Once the low emitters earn sufficient carbon credits, they can be transacted with the high emitters in society.

Instead of allocating per capita carbon credits equally to everyone, selective distribution of the carbon credits should be made. For example, the low emitters who are normally poor and residing in slum or rural areas should be targeted first. Typically, they are the beneficiaries in most of the government's schemes related to sanitation, housing, and agriculture. Instead of distributing 'subsidies' for toilets, houses, and fertilizers, the option of carbon credits could be considered.

The profits in terms of carbon credits will make the process selective and thereby competitive. By adopting cleaner sanitation technologies, green housing materials in construction techniques, and organic fertilizers, there are fair chances for low emitters to earn carbon credits and transact with high emitters and industries. The benefits generated through the transaction will make the PCT scheme competitive, eventually promoting the desired green lifestyle.

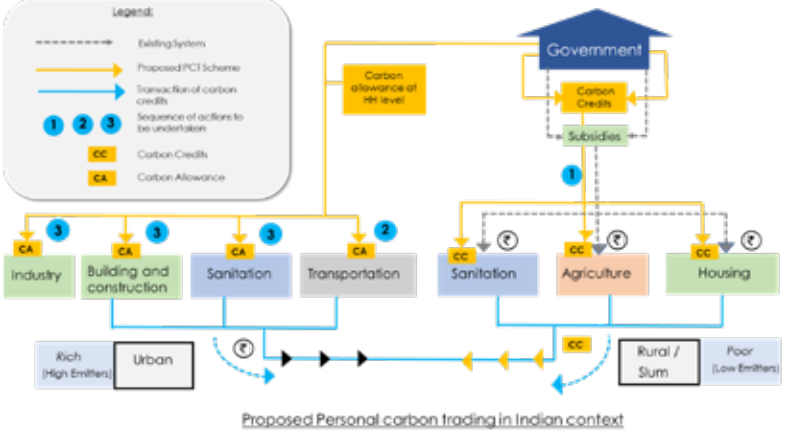
Proposed PCT Scheme in the Indian Context

Carbon transaction between low emitters and high emitters is the basis of the proposed PCT design in the Indian context. In this process, the sanitation sector would be targeted first. Consequently, the toilet owners will receive the carbon credits worth the subsidy provided by the government. They can redeem their credits by producing and selling the manure to the farmers. The buying and selling process would happen

through the exchange of these carbon credits. Once the cost of the toilet is recovered, the users will be free to earn their benefits by selling the market-quality manure, generated by the organic decomposition of the dry faecal matter and household organic waste, to high emitters. Similarly, farmers can earn their carbon benefits by producing organic food and practising low carbon farming. In contrast, rural household beneficiaries can receive carbon credits worth the subsidy amount but cannot earn further credits like ecological toilet users and organic farmers. However, they can sell their credits in the market to high emitters.

Once the partial PCT scheme is established for low emitters, the high emitters – urban households, industries – will be permitted more carbon allowances. If they exceed their limits, they can purchase extra credits from low emitters (Figure 1). In this manner, the carbon market can function organically. Laterally, such a PCT scheme would be able to address the existing socio-economic disparities in India.

The prime contributors of GHG emissions in India are the transport sector (24%), building sector (32%), agriculture sector (20%), waste (2%), and industrial processes (6%) (IPCC 2018). The highest emitter would be targeted once the carbon market is established within a smaller scope, i.e., with the help of low emitters. The sequential targeting of the sectors will make the PCT more feasible, far less complex, and more desirable.



» Figure 1: Proposed personal carbon trading scheme in the Indian context

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ECORIGHT

Despite continuous efforts made by government bodies and citizens of the country to curb the menace of plastic waste generation, India continues to produce 9.46 tonne plastic waste every year.

Being accustomed to an eco-conscious lifestyle, my family and I firmly believe that consciousness toward our environment and sustainable development are absolutely necessary. As co-founders of EcoRight, my husband, Udit Sood, and myself, Nikita Barmecha realized that to address concerns pertaining to plastic pollution, plastic consumption must be drastically reduced. Before co-founding EcoRight, I worked at the CFO's office at Airtel as a strategy analyst and prior to that, I was a risk and currency trader for the Bharti Group. I completed my MBA from IIM Calcutta and graduated as a BCom (H) student from SRCC, Delhi.

Before EcoRight, my husband was Associate Vice President, Zomato, where he led the revenue and content operations for the online ordering business. He also worked as a brand manager at Unilever and at the Tata Administrative Services. He holds an MBA degree from IIM Calcutta and has completed his BEngg (H) from the University of Queensland.

In 2017, our team set out to raise awareness on conscious consumption and develop fun, organic, and reusable products that would help sustainability become a topic of mainstream discourse. Single-use plastic bags were being rampantly used at the time and we needed to bring a change in that area. We began with one sustainable bag in place of a plastic one. And we have been branching out since. A sustainable process is at the core of what we do and the root is eco-friendly materials. Organic cotton, recycled plastic, and juton (50% jute, 50% cotton) ensure a sustainable impact, thereby promoting the usage of lesser water, lesser energy, and fewer resources. We collect organic cotton from farms and use that for most of our bags. Recycled plastic contributes to unclogging our landfills and oceans; so, we go to those suppliers that are certified by GRS (Global Recycling Standard) and we collect the bottles for reuse. We also recycle cotton which ensures 36% reduced carbon footprints. Juton is another material we deal with. Apart from the advantage of being tough (like jute) and lightweight (like cotton), juton helps curtail harmful emissions to an estimated 38% per bag.

All our products are ethically sourced and are certified by SEDEX, SA8000, Organic (GOTS, OCS), and Recycled (GRS, RCS). One of our key goals is to re-engineer our manufacturing and supply chain process to be entirely sustainable. Our factories are solar-powered and employ rainwater harvesting facilities. From day one, we have used organic dyes that are 100% azo free. Inclusive environmentalism is essential for our sustainable

journey, so our work environment ensures fair wages, high safety standards, no discrimination, and opportunities for our workers' growth. Also, we have undergone the process of getting Fair Trade and Sedex 4 pillar certified to meet our goals.

Our design philosophy is simple. We are inspired by everything in our ecosystem and our philosophy promotes being earth-kind and animal-friendly. We pack all our products in eco-packaging sleeves made from cornstarch that are 100% biodegradable and compostable. All this is part of a slow and sustainable process we truly enjoy. Our stakeholders include every conscious consumer, NGOs we have tied up with, and a conscious audience. We have designed a simple programme. At the end of each eco-friendly purchase from our website, 10% is reserved as an investment for our planet. The customer selects a cause for donation. For this, we have collaborated with CARE Foundation and SayTrees, both engaged in efforts at the grassroots to help our community become a better place. The simple realization is that, whatever we do returns to us. Our planet motivates us to take conscious steps for a better and sustainable future. The least we can do to envision a greener future is to consciously choose what is good for us and our planet.

POWER CURRENCIES

Understanding Bitcoin's Energy Usage

The future of cryptocurrency is a topic of discussion worldwide. However, have we ever stopped to think about the total electricity consumption of the Bitcoin network? In this thought-provoking article, Shibani Choudhury and Sujay Choudhury present a different perspective to the Bitcoin revolution in the finance ecosystem in terms of sustainability, energy efficiency, trust issues, and more.

Shibani Choudhury, Project Officer, GRIHA Council is an architect, registered with the Council of Architecture, India. She is a distinction awardee from the Architectural Association, London with an MArch in Sustainable Environmental Design. With almost three years' experience, her core focus lies in reducing whole life carbon in the built environment through data-driven architecture. She can be reached at shibani24@gmail.com.

Sujay Choudhary is an architect, who is part of the management team of Profile Developers, Pune. He has completed his post-graduation in Construction Management from NICMAR, Pune and is currently pursuing his MArch in Housing and Urbanism from the Architectural Association, London. His interest in finance and economics drives his pragmatic approach to architecture. He can be contacted at sujayc135@gmail.com.

Bitcoin is a decentralized digital currency that enables instant payments to anyone anywhere in the world and tackles trust issues of centralized banking systems, such as hyper-inflation, high transaction costs, etc. It has all the properties of a good currency, i.e., it is portable, durable, divisible, recognizable, fungible, scarce, and difficult to counterfeit. However, one major drawback is that the Bitcoin network has a high rate of energy consumption. As organizations around the world face pressure to limit their consumption of non-renewable energy sources and the emission of carbon into the atmosphere, it is important to discuss the impact of Bitcoin on the environment (Figure 1).

The key to understanding Bitcoin energy demand is to look at its method of transaction. Bitcoin employs public key cryptography, peer-to-peer networking, and a proof-of-work

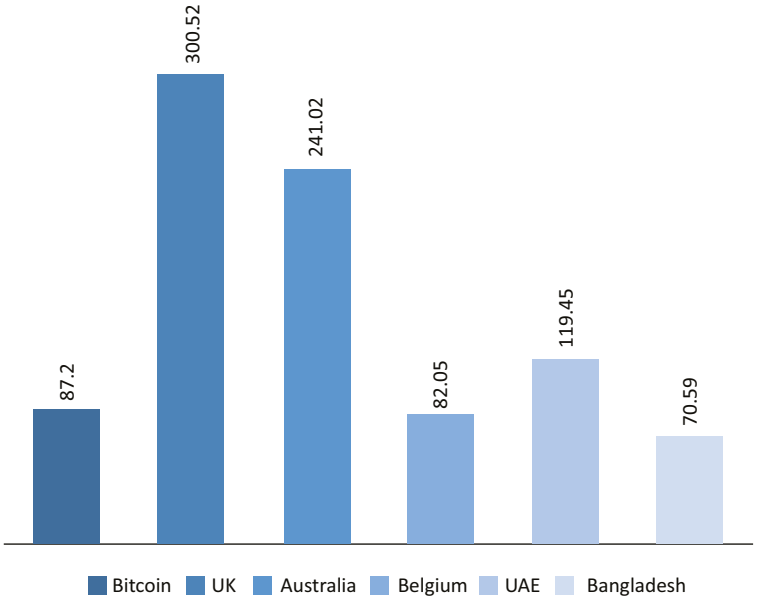
» **Figure 1:** Bitcoin and the environment

> "I've developed a new open source P2P e-cash system called Bitcoin. It's completely decentralized, with no central server or trusted parties, because everything is based on crypto proof instead of trust. The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust. Banks must be trusted to hold our money and transfer it electronically, but they lend it out in waves of credit bubbles with barely a fraction in reserve. We have to trust them with our privacy, trust them not to let identity thieves drain our accounts. Their massive overhead costs make micropayments impossible ." This is an extract from an email written by Satoshi Nakamoto, an alias used by the individual or group that developed the system of Bitcoin (Nakamoto 2009).

consensus algorithm to process and verify transactions in order to maintain a decentralized ledger or a public ledger. In simple terms, each payment mechanism must have a system to record transactions which is known as a ledger, and in a decentralized ledger, there can be no central party or a bank managing it. This is where mining or miners play a big role. Mining is the process of adding transactions or a block to the public ledger or the blockchain, and in turn, the miners receive a payment for their services in Bitcoin which is about 6.25 BTC per block. The opportunity to add a new block to the ledger is given approximately every eight minutes and is awarded to the first miner who is able to solve a computational mathematical puzzle developed using the SHA256 algorithm (Bitaps 2021). This means that the miners have to guess a 64-digit hexadecimal number known as a "hash", the first miner to get it right is given the chance to add transactions to the block which is then validated by the network and in turn rewarded. This is known as the proof-of-work consensus. The process of mining is intentionally designed or programmed to be resource-intensive and difficult so that the number of blocks found each day by miners remains steady. Also, as more people start either mining on their own or joining mining pools, the blockchain is programmed to increase the difficulty level of guessing the hash. This results in an increase in the computing power and in turn a rise in energy consumption.

Over time, Bitcoin mining has evolved from using central processing units (CPUs) to general processing units (GPUs) and field programming gate arrays (FPGAs), and now, it makes use of application-specific integrated circuits (ASICs) which are hardware-specialized. Mining farms use a number of such devices to enhance their computational power in order to increase their probability of being able to add a new block to the blockchain and gain rewards in Bitcoin. Naturally, greater computational power will result in higher power consumption. Such clustered powerful computers apart from directly consuming electricity to run, also release a lot of heat,

» **Figure 2:** Mining rigs



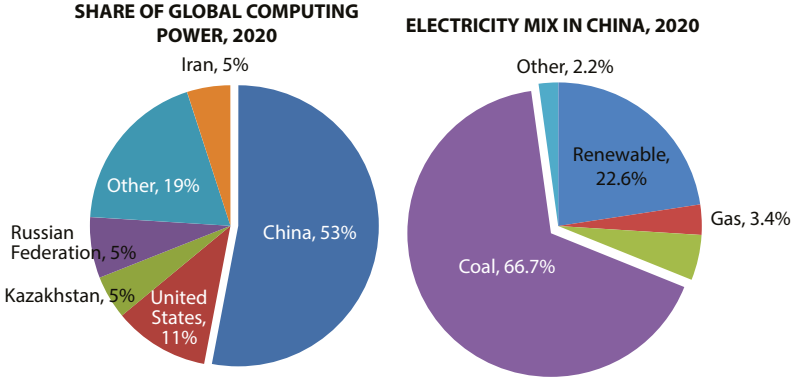
» **Figure 3:** Bitcoin vs countries in annual energy consumption

the cooling of which is termed as secondary energy expenditure (Figure 2). A tertiary problem is that of disposal of energy waste.

According to the hypothetical range calculated by the Cambridge Bitcoin Electricity Index (CBEI), Bitcoin's annual electricity consumption is 87.20 TWh. To put this into perspective, the energy consumption of the entire Bitcoin network is more than the country of Belgium, which uses 82.05 TWh (Figure 3). This means that it takes 1704.78 kWh of energy for one Bitcoin transaction to complete, as estimated by CBEI (University of Cambridge 2021). This is equivalent to the annual power consumption by 1.5 persons in India today (CEA 2020). The source of this energy is largely coal and fossil fuel-based, which is the primary cause for concern (Figure 4). A single Bitcoin transaction has a carbon footprint of 809.77 kg CO_2, which is equal to driving a petrol-fuelled car for 3500 km (Tata Power 2021). With such a large footprint, the most popular cryptocurrency is adding to an already growing climate crisis.

Many sustainable projects do exist in the crypto-ecosystem that work on different consensus mechanisms such as proof-of-stake or proof-of-storage, and these do not require mining. Projects such as Cardano, Holochain, and Algorand are good examples of cryptocurrencies that are eco-conscious and have great teams working on them to ensure that they stay eco-friendly when scaled up in terms of transactions. There could be a debate that such cryptos would eventually prove to be more sustainable than our banking infrastructure if we account for the amount of energy spent on creating these structures, their huge workforces, machinery, and database.

However, Bitcoin is still the most valuable of the lot and is expected to maintain its dominance in the future. But, what makes Bitcoin so popular? While numerous other cryptocurrencies have been developed and are currently being traded, Bitcoin, which launched in 2009, was the first to arrive at the scene. It has since gained the trust and repute of traders and investors alike. Its proof-of-work algorithm is well thought of in terms of security and decentralization. Just like some of the world's precious metals, the Bitcoin supply is limited. There are only 21 million Bitcoins in the world, and with the depletion in its supply, its demand is rapidly gaining traction. This is further fuelled by the absence of the mysterious creator or creators/group and the possibility of change in the blockchain protocols. As of 21 August 2021, the Bitcoin dominance index was at 44%, i.e., in



» **Figure 4:** Bitcoin energy source

» **Figure 5:** Architecture for data centres

the crypto-ecosystem which has more than 11,000 cryptocurrencies, 44% of all transactions are done in Bitcoin (Trading View 2021). So, if Bitcoin maintains its position as the top cryptocurrency, it is a likely scenario that data mining will continue at an extensive rate even with sustainable alternatives available.

However, unlike most industries, Bitcoin infrastructure is mobile and can be set up at remote facilities or locations. The environmental impact of Bitcoin can be controlled through evolved processes, regulatory interventions, and change in the source of power. The root of the problem, i.e., the dependence on fossil fuels must be eradicated. Mining farms could be set up in proximity to renewable energy sources to reduce transmission costs and losses. The switch to clean energy sources is possible provided costs are kept low enough for Bitcoin mining to remain profitable and sustainable. Aggressive mining for this popular coin must be analysed and controlled.

Although companies are in a race to create more energy-efficient and sustainable mining hardware, stricter laws and hope for research and development alone will not suffice. We also need to look at or tackle the problem from a different perspective, such as the design aspects of the structures that house such energy-intensive functions (Figure 5). This is an exciting challenge for the construction sector to contribute to decentralized finance and financial technology. The need is to sustainably design structures that are meant to house and optimize the conditions for such energy-intensive hardware. Such a new movement in architecture was beautifully highlighted and addressed by Rem Koolhas in his talk, "The Art of Figuring Out How the World Works", where he discussed the issue of enormous infrastructure in the digital age and the architecture required to support these institutions, where we were not designing for humans but the machines that would inhabit these structures.

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Carbon Pricing as a Sustainable Instrument

A carbon price is about taking responsibility to reduce emissions. In this article, Amlan Shome discusses the usefulness of a carbon tax imposition and how it could be a cost-effective way to mobilize investments, thereby encouraging non-polluting companies and businesses. However, is carbon pricing enough to mitigate climate change risks? Read on to find out more.

Amlan Shome is a final year undergraduate student at KIIT University, Bhubaneswar. His specialization is in mechanical engineering with a special focus on renewable energy. His areas of interest include carbon markets, green buildings, and energy efficiency. Presently, he is interning at a start-up in the ESG consulting space and is associated with an NGO that raises awareness on climate change. He can be reached at amlanshome258@gmail.com.

Introduction

Climate change is one of the most pressing global issues our generation is battling today. It has the potential to reverse decades of development gains by endangering lives, livelihoods, and economic prosperity. Humans are to be held accountable for global warming because of their excessive reliance on fossil fuels. In the past few years, extreme weather-related incidents have become significantly more intense. In its latest report, the Intergovernmental Panel on Climate Change (IPCC) gives a glimpse of the road ahead of us. The report brings together the latest advances in climate science, combining multiple lines of evidence from paleoclimate, observations, process understanding, and global and regional climate simulations. It suggests that human influence has undoubtedly warmed the atmosphere, oceans, and land leading to widespread and rapid changes in the atmosphere.[1] It sends a strong signal that if countries do not respond immediately, it will have disastrous consequences for agriculture, water supplies, ecosystems, and human health.

There would be widespread food shortages, unprecedented heatwaves, and more intense storms if the planet gets warmed by 2°C. According to research, nearly 1.5°C of warming has already been locked in. The world will need to reach net zero emissions by the end of the century to keep below 2°C. That would require taking action right now.

1 IPCC. 2021. *Headline Statements from the Summary for Policymakers. Sixth Assessment Report*; Working Group 1, Physical Science Basis, IPCC

What is Carbon Pricing?

Carbon pricing is a novel strategy to mitigate climate change risks. It has been recognized as a necessary part of any serious climate policy. Governments can price carbon in a variety of ways, all of which lead to the same conclusion. They begin to capture the external costs of carbon emissions, which are expenses that the public pays for in other ways, such as agricultural loss and healthcare expenditure due to heatwaves and droughts, or property damage due to flooding and sea level rise, and attach them to their sources through a carbon price. A carbon price serves to shift the responsibility for the damage back to those who cause it and can mitigate it. Instead of mandating on how to cut emissions, a carbon price sends an economic message to polluters, allowing them to choose whether to stop polluting, reduce emissions, or continue to pollute and pay the price. As a result, the overall environmental aim is met in the most flexible and cost-effective manner possible for our society. The carbon price also encourages clean technology and market innovation, resulting in the development of new, low-carbon economic growth engines.

Carbon pricing, which is set by governments or markets, covers a portion of a country's total emissions by either taxing or charging CO_2 emitters for each tonne released. These levies might also apply to methane, nitrous oxide, and other greenhouse gases (GHGs) that contribute to global warming. Carbon pricing uses market mechanisms to generate financial incentives for people to switch to more energy-efficient processes or cleaner fuels in order to reduce emissions.[2]

Broad Classification

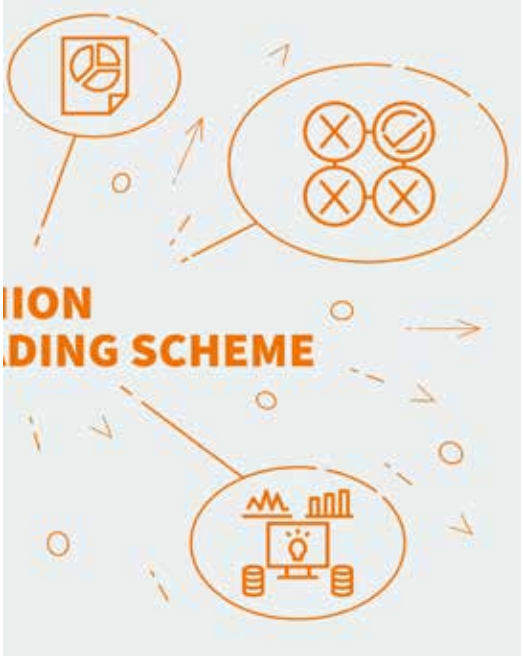
There are two main types of carbon pricing: emissions trading system (ETS) and carbon taxes.

[2] Baranzini, A., C. J. M. van den Bergh, Jeroen., S. Carattini, R. B. Howarth, E. Padilla, and R. Jordi. 2017. Carbon pricing in climate policy: seven reasons, complementary instruments, and political economy considerations. *Wires Climate Change* 8(4). Details available at https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wcc.462

An ETS, also known as cap-and-trade system, sets a limit on the total GHG emissions and permits low-emitting companies to sell their excess allowances to higher-emitting industries. An ETS provides a market price for GHG emissions by creating supply and demand for emission allowances. The cap ensures that the necessary emission reductions are made for emitters to stay within their pre-allocated carbon budget. The government sets a ceiling or cap on the total quantity of emissions allowed within the framework of ETSs. Allowances are provided to the scheme's regulated businesses either for free or at an auction. After that, each company has the liberty to emit up to the permissible limits. They can also swap allowances with one another to satisfy their own emission targets. Those who emit more than their allotment can buy more credits, while those who emit less can sell or bank their excess credits. A carbon tax places a direct price on carbon by imposing a tax on GHG emissions

or, more typically, the carbon content of fossil fuels. In other terms, it imposes a tax on the consumption of fuel or energy.

Emissions trading systems (ETSs) and carbon taxes differ in several ways. Carbon taxes ensure cost certainty because the price is established by the government. However, emissions are unrestricted as long as regulated organizations are willing and able to pay for the same. ETSs, on the other hand, provide quantitative figures in terms of the cap set by the government, which represents the upper limit on emissions. The price fluctuates depending on either the scarcity or oversupply of permits. The two are often used interchangeably in practice. An ETS, for example, can have a guaranteed price, which makes it resemble a tax.



Second, unlike ETSs, carbon prices are relatively simple to establish and implement. Governments have a long history of collecting taxes. ETSs are fairly complicated. Governments must determine the limit. While science is an important factor, it is also a function of expected costs. Therefore, governments must distribute and/or auction allowances, as well as develop a framework for tracking and trading them. Governments frequently auction allowances for multiple years at the same time, thereby affecting future pricing.[3]

[3] Green, J. F. 2021. Does carbon pricing reduce emissions? A review of ex-post analyses. *Environ*. Res. Lett. 16(043004)

Picking the Right Tool

The instrument chosen will be determined by the country's economic situation. Fuel taxes, the elimination of fossil fuel subsidies, and other indirect methods of carbon pricing exist as well. Payments for emission reductions can also be used to price GHG emissions. Emission reductions can be purchased by private entities or sovereigns to compensate for their own emissions (offsets) or to fund mitigation actions via results-based financing (RBF).

If governments allow offsets as part of a carbon price strategy, they will have to establish or adopt procedures for offset projects, which would qualify as emission reduction by allowing polluters to pay for decarbonizing operations elsewhere. Offsets also necessitate a system for ensuring that projects achieve the estimated reductions. Carbon pricing is not exclusively a domestic climate policy; it has been and will continue to be a fundamental part of the multilateral climate change framework. The 2015 Paris Agreement gave carbon pricing a major role. Countries can

trade "internationally transferred mitigation outcomes" under Article 6.2. In essence, a government that has surpassed its Paris obligation to reduce emissions can sell the excess to another country. Article 6.4 establishes the UN-managed Sustainable Development Mechanism, a new international carbon market. It will take the place of the Clean Development Mechanism (CDM), the Kyoto Protocol's offset market. Furthermore, the utilization of foreign markets is not restricted to the Paris Agreement. In 2016, the International Civil Aviation Organization created a new plan to address aviation emissions, which were not covered under the Kyoto Protocol.[4]

The Way Forward

This conviction in carbon pricing's effectiveness is evident in its widespread and expanding use.

There are 30 carbon taxes and 31 emissions trading schemes in place around the world, accounting for 22% of worldwide emissions. Following the 2015 Paris Agreement, a better understanding of the structural adjustments needed across the global economy to transition to a low carbon economy has emerged. Carbon emissions are likely to be increasingly regulated through taxes, emissions trading schemes, and fossil fuel extraction levies as part of global efforts to combat climate change.

Carbon prices in Europe have been continuously climbing under the EU Emissions Trading System (EU ETS) since 2016, reaching an 11-year high in July 2019. Higher carbon costs could help clean energy generators in Europe, such as wind, solar, and nuclear power plants, thereby increasing profit margins. CO_2 emitters in the UK, for example, pay more to emit carbon than most of their European peers, allowing the country to phase out coal power generation quickly. Carbon costs are also helping to boost gas-fired profitability in comparison to coal-fired profits, as well as encouraging investment in the much needed technologies like carbon capture.

According to data from S&P Dow Jones Indices, carbon pricing could result in huge expenses for corporations in the transition to a low carbon economy, amounting to as much as US$1.3 trillion from 2030 carbon prices across companies in the S&P 500. S&P Dow Jones Indices established the S&P Carbon Price Risk Adjusted Index Series to account for the additional costs and hazards of future carbon pricing, allowing investors to evaluate 2030 carbon price risk exposures in addition to business profitability when making investment decisions.

A carbon price's long-term purpose is to transition away from carbon-intensive manufacturing and consumption. This will require considerable investment and R&D to envision a sustainable future.

[4] Neuhoff, K. 2011. "Carbon Pricing for Low-Carbon Investment." Climate Policy Initiative/DIW Berlin

Testimonial

Jammu Airport Terminal

Mr M M N Rao
Executive Director (Engg)-NR
Airports Authority of India

"Acquiring the GRIHA Existing Building '4-Star' rating was an absolute recognition and one-of-a-kind experience for our entire project team. The project team was closely involved in the GRIHA Existing Building-related documentation and site audits. As a rating process, the GRIHA team audited the existing terminal building at the Jammu Airport. The project implemented no-cost energy efficiency measures (EEMs) to reduce the annual energy consumption compared to conventional terminal buildings. Indoor environmental quality measures were ensured during the audit including sufficient artificial lighting levels, daylight levels, temperature, humidity, air velocity, fresh air ventilation, and acoustic comfort. Also, the key parameters for operation and maintenance (O&M) were audited including electrical, mechanical, and plumbing equipment requisites along with environment-friendly housekeeping considerations.

During campus operations, water conservation was achieved. Wastewater was treated through passive means like soil biotechnology sewage treatment plant, and the treated water was reused within the campus. This practice not only helped conserve water but also considerably reduced the overall electricity consumption (otherwise used by active electromechanical systems)."

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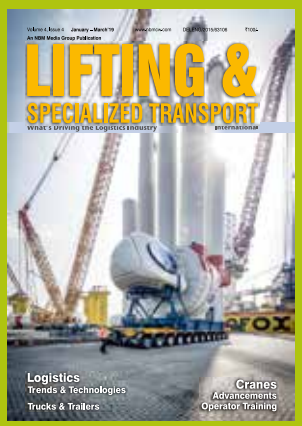

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Air Leakage in HVAC Systems

Small Problem, Big Impact

The assessment of energy loss in centrally air conditioned systems is often a neglected area in mainstream discourse on energy consumption and environmental degradation in an age of technological advance. In this article, Anne Sharon highlights how air conditioning is a mature industry and that there is an urgent need to rethink systems and designs to improve performance efficiency, reduce costs, and ensure sustainability.

Anne Sharon works with Consergy Systems and Technologies LLP that aims to bring cutting-edge HVAC solutions focused on energy savings and green economy. She is an avid tech geek and marketer who loves working in areas of green energy and sustainability. An engineer by education and training, she takes great interest in understanding new technologies and their impact on human lives and the environment. She is also passionate about actively communicating the benefits of new clean air technologies to the community and bringing about positive behavioural changes which could help corporates save energy and protect the environment.

Introduction

With urbanization, there has been a tremendous increase in the expansion of cityscapes throughout the country. With the improving quality of life of the urban working population, the need for comfortable working spaces has also grown manifold. This has led to a rise in buildings with many modern amenities such as central air conditioning systems, efficient lighting systems, ergonomic seating arrangements, large green spaces, etc., all aimed at improving the comfort of the occupants. Of these, the central air conditioning systems are of particular interest when it comes to energy saving and environmental benefits.

ASHRAE

75% of buildings have leaky ductwork, helping make HVAC the diggest source of energy waste

BERKELEY LAB

$2.9 billion is the annual cost of energy wasted by duct leakege

Energy Loss in Centrally Air Conditioned Systems

Central air conditioning systems have become integral to various modern structures, such as office buildings, state-of-the-art manufacturing facilities, hospitals, hotels, schools, and others. Given that our country experiences variations in climatic conditions, the central air conditioning systems must be designed keeping in mind the specific requirements of a given city or state.

These systems consume more than 50% of the total energy in the building. This makes them the largest consumer of energy in any building system. Incidentally, these systems also happen to waste a lot of valuable energy through various inefficiencies. One such inefficiency is the issue of leaking air ducts. There

is substantial air loss in the ducting systems that carry conditioned air throughout the building. This forces the air conditioning equipment to operate at a much higher load than what is permissible according to the design parameters, thereby leading to considerable energy loss. Air leakage through the ducting system usually exceeds the standard design parameters as set by the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

Such increased loads on the air conditioning system continue to not only increase costs for the individual stakeholders but also contribute to pollution. These uncontrolled losses in buildings eventually increase the overall energy consumption and when aggregated at a national or international level, this has a negative impact on the environment and our limited stock of natural resources.

Air Loss through Ductwork – Small Problem, Big Impact

A scientifically designed central air conditioning system would not just ensure that occupants have the right temperature and humidity requirements, but would also be energy-efficient, require less maintenance, and would adapt based on the load variations in the building. As air conditioning is a mature industry, there is an urgent need to rethink systems and designs to increase performance efficiency and reduce costs. In the last decade, a lot of research and resources have been dedicated to increasing the efficiency of the various machines and components that form a part of the central air conditioning systems. These include chillers, air handling units (AHUs), fan coil units (FCUs), variable frequency drives (VFDs), dampers, automation control units, and several others.

What has been alarmingly left out in these developments is the fact that air leakage is a major cause of energy loss in HVAC systems. And this happens through the ductwork. The cold air circulates inside a centrally air conditioned building through ducting systems that run like branches along the length and breadth of the building. These are usually fabricated out of sheet metal and are built to carry the conditioned air across the building from the central AHUs. These ducts are usually factory fabricated and built to last, but their interconnections are not leak-proof. Over time and due to general wear and tear, this central ductwork begins to develop gaps at the joints and connections, and this becomes a potential point for air leakage.

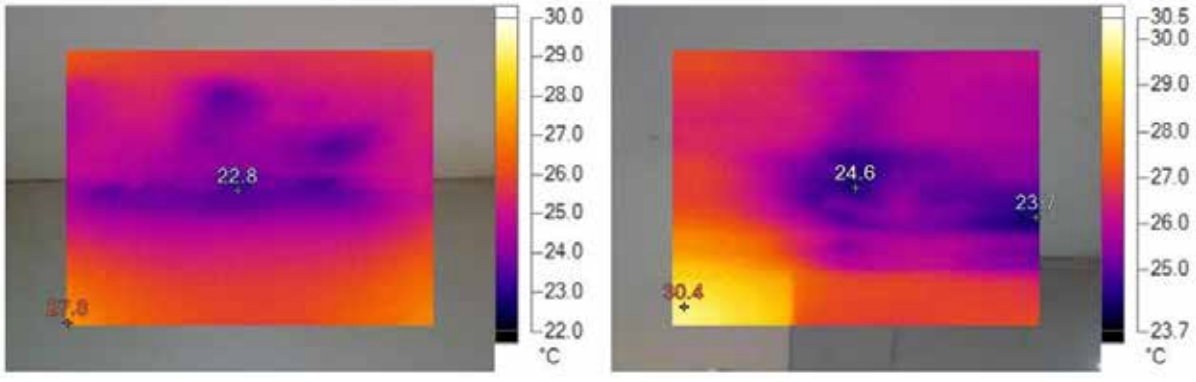
These gaps can be as small as 1 mm in thickness and can also sometimes be as wide as 20 mm or more. Because of this, there is substantial loss of air that circulates through the ductwork. As a result, the designed CFM (cubic feet per minute) of the AHU is not reached, i.e., if the AHU is designed to pump in 25,000 CFM of conditioned air into a particular room or shop floor, considering a modest leakage of 10%, there will be a loss of 2500 CFM of air in this system. This will further lead to loss in pressure in the duct and result in additional load on the AHU. The AHU will now operate at a higher capacity and increase the energy consumption.

Impact Due to HVAC Duct Air Leakage

Air loss in the ducting system can cause several related problems, ranging from simple comfort issues to serious contamination problems.

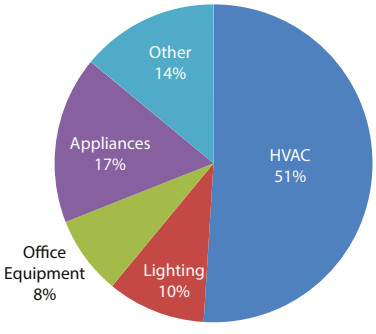
In office buildings, the direct impact of a leaky ductwork can be seen in the presence of hot and cold zones inside the work area. While some employees might whine about insufficient cooling in their rooms, others might complain of unbearably cold work areas. This leads to frequent calls to the maintenance department, whose personnel usually attempt a quick fix solution like temporarily increasing or decreasing the temperature on

Example of Air Leakage above False Ceiling as seen by Thermal Imaging Camera



the thermostat. They are usually not aware of the underlying issue and hence the problem is never resolved. Therefore, it is important to maintain a comfortable workspace for employees as this has a direct impact on their performance and mental health. In manufacturing units, especially in pharmaceuticals and food production, there is a serious issue of cross-contamination. When the ductwork leaks, there is a possibility that contaminants from one room might enter another room through the ducting system. When highly contaminating materials like cancer cells or radioactive substances are being handled, this problem becomes critical. This further leads to major product quality concerns and serious code compliance issues as well.

Average Energy Consumption in a Centrally Air-Conditioned Office Building



In hotels, air leakage through ducts causes uneven heating and cooling in various rooms. This has an impact on the occupant's comfort level and if not attended to immediately, severely affects the brand value of the property. By effectively sealing air leakages in the ducting system, the capital efficiency including the life of the equipment can be favourably extended.

Reasons for Air Leakage

While a lot of effort has gone into improving the efficiencies of the HVAC systems over the last decade, the air distribution systems have been largely ignored. This is primarily due to lack of awareness. A key reason that contributes to this lack of awareness is that most of the ductwork in modern buildings is concealed either under the false ceiling or is hidden inside central shafts along with other plumbing and electrical lines. Due to this, the problem is never visible and hence goes unaddressed. Even in cases where stakeholders are aware of the problem of air loss through the ductwork, there is no way to quantify this loss and link it to energy loss. Hence, the problem gets ignored and forgotten yet again.

What Can Be Done?

In recent times, there are new services in the market that address air balancing and air leakage issues. These can help overcome the problem of energy loss, thereby bringing in substantial cost savings to different stakeholders. Several large corporations have sustainability goals that seek to reduce the carbon footprint of these organizations. They must take cognizance of this key issue in their air distribution systems, which will make an impact on their sustainability goals. This will go a long way in containing the impact of global warming in addition to making our workspaces safer and more comfortable for our people.

Passive Solar-Heated Buildings

Solution to Sustainable Thermal Comfort in Ladakh

In this article, **Dr Priyam Tewari** discusses the challenges of finding sustainable solutions to thermal comfort in high altitude regions of India, especially Ladakh. The region suffers a considerable deficit in power supply and inhabitants face tough living conditions, particularly during peak winters. In this regard, Dr Tewari highlights the importance and relevance of passive solar-heated buildings in difficult terrains like Ladakh.

Introduction

Often known as the 'cold desert of the country', Ladakh has an extremely harsh and long winter season. Significant variations in the terrain and limited connectivity by all-weather roads have inhibited the region's overall development. For Ladakh, development is a priority, but mainstreaming climate action into the development efforts of building infrastructure and creating economic opportunities are paramount to evade carbon-intensive selections and protect the region's unique natural ecosystem. After being declared a union territory (UT) in 2020, Ladakh has been envisioned to become carbon neutral by 2050 (Administration of Union Territory of Ladakh 2020).

The "Vision 2050" developed by the administration of the UT of Ladakh enlists the key challenges, focus areas for advancement, and outlook of the UT to accomplish its goal of carbon neutral development. Presently, Ladakh suffers a 36% deficit in its power supply with no supply for almost 30% of the day, thereby compelling heavy reliance on fossil fuels including coal, kerosene, diesel, etc., for meeting the rising energy demands. This poses a serious threat to the environment (Administration of Union Territory of Ladakh 2020).

With the envisioned development in various sectors including all-weather tourism, education and institutional infrastructure, forthcoming economic centres, etc., a huge building stock is expected to come up in the region during the next decade. Associated construction activities owing to an increasing population and urbanization will result in the disrupted rise in energy consumption patterns particularly due to space heating load of the buildings.

Current Scenario

Majority of the existing building stock in Ladakh is poorly insulated with high air leakage rates and infiltration, providing poor indoor thermal comfort to the occupants. Poor construction quality and excessive use of high embodied construction materials also significantly contribute towards higher carbon emissions and inferior quality of indoor comfort in the

Dr Priyam Tewari is Associate Fellow, Sustainable Buildings Division, TERI. A mechanical engineer by training, she was felicitated with the prestigious Building Energy Efficiency Higher & Advanced Network (BHAVAN) Award in 2018. Her areas of research include thermal comfort, passive cooling, and building energy efficiency. She is also a founding board member in IBPSA India, an affiliate of International Building Performance Simulation Association.

buildings. The districts of Ladakh, Leh, and Kargil have a higher share of residential buildings than either commercial or industrial. Firewood, coal, kerosene, diesel, and other carbon-emitting fuels in traditional *bukharis, chulas, kangri,*[1] stoves, etc., have been widely used by local residents for thermal comfort in harsh winter conditions (WWF-India and TERI 2020). Military settlements and commercial buildings continue to be majorly dependent on electric heating systems. For electricity supply, the inhabitants tend to rely on conventional diesel gen-sets, which ultimately lead to negative environmental effects, thereby contributing to GHG emissions and local pollution. Moreover, lesser oxygen availability at higher altitudes aggravates the problem of black carbon emissions due to inefficient combustion of diesel. There is a remarkable growth in electrification of the region, but when it comes to meeting the heating requirements, electricity has proven to be a challenge due to its erratic supply as it becomes incapable to handle higher power loads of electric heaters.

With increasing energy shortages and extremely low outdoor temperatures, ensuring indoor thermal comfort in buildings through low-cost and environment-friendly means is imperative to climate change scenarios, socio-economic development, and the region's fragile ecology. Therefore, it is important that new buildings consume less energy for heating purposes and opt for clean energy alternatives. The construction and operation work should minimize the usage of auxiliary heating requirements for most part of the year. Well-designed and efficiently operated buildings can significantly lower GHG emissions without compromising on the thermal comfort needs in the built environment.

Passive Solar Heating for Low Carbon Development

The concept of passive solar heating (PSH) translates to capturing heat from sunlight through an efficient building envelope design by following the parameters of glazing, thermal mass, thermal storage, etc. The generated heat is released and circulated inside the building to regulate the indoor temperature without substantial use of either active mechanical or electrical devices (NREL 2021). The integration of

[1] These are traditional Indian kitchen appliances used for cooking purposes. Kangri is a portable fire-pot which keeps people warm during harsh winter months.

passive solar design in the building architecture requires consideration of consciously embedding climate-appropriate passive solar heating techniques/strategies, such as direct gain, indirect gain, and isolated gain in the building design. The direct solar gain design allows sunlight to directly enter indoor spaces through windows (usually south-facing) and strike masonry floors and/or walls, which in turn absorb and store the solar heat. The indirect solar gain allows storage of heat collected from the sun in the air space between the glass and dark material, and transfers the heat slowly to the interiors of the building through conduction and convection mechanisms. Trombe walls, designed on the concept of indirect solar gain, find applicability in space heating applications. The use of high thermal mass, insulation, and thermal storage systems (via water blocks, water-filled containers) helps maximize the thermal comfort of the built environment in the cold regions with abundant solar resource availability.

With over 300 days of bright sunny days, Ladakh has tremendous potential to meet dominant space heating requirements of the present and future building stocks, albeit passively, by utilizing the natural solar heat. The integration of a solar passive design and adoption of passive solar heating systems can minimize carbon emissions associated with the building sector in the region. Several NGOs have been promoting the PSH building technology, but with very limited accomplishment despite successful demonstration projects.

The promotion of the passive use of solar heat for heating buildings is the goal of an international research project titled, "Passive Solar-Heated (PSH) Houses in Ladakh, India" (FHNW n.d.). The Swiss Agency for Development and Cooperation (SDC) has engaged with the Himalayan Institute of Alternatives (HIAL), Ladakh, India; TERI, New Delhi; and the University of Applied Sciences and Arts Northwestern Switzerland for a collaborative research project. Apart from its active engagement in other project activities, TERI is leading the qualitative and quantitative study of indoor thermal comfort in PSH buildings by conducting field measurements in the actual buildings of Ladakh. TERI has trained the locally stationed HIAL team on survey data collection methods and protocols. This study is one of its kind and a first attempt to quantify the occupants' thermal comfort in the PSH buildings of Ladakh. Out of the 21 surveyed buildings, 12 buildings were PSH, while nine buildings were in the non-PSH category.

Observations and Conclusion

Some of the major observations of the research team are as follows:

- PSH buildings demonstrate advanced levels of thermal comfort; feedback from occupants indicates higher degree of thermal acceptance. Active heating systems are mostly operated during rainy days.
- Locally sourced materials such as clay and soil from nearby villages used during the construction of PSH buildings offer advantages of achieving high thermal mass with reduction in embodied energy.
- Integrating passive techniques such as solar verandas, Trombe walls, greenhouses, etc., and utilizing the best practices of passive solar design such as south-facing large windows with high window-to-glass ratio, efficient glazing and building material, thermal storage mechanisms, etc., are found to maintain the average indoor temperature above 15°C in PSH buildings during peak winters when the outdoor temperature is far below 0°C.
- For maintaining a comparable degree of thermal comfort in non-PSH buildings, the average usage of auxiliary heating systems (*electric heaters,* bukharis *or kerosene/wood stoves*) is significantly higher (more than 12 hours/day) than in PSH buildings.
- Layers of clothing opted by occupants in PSH buildings are found fewer than in non-PSH buildings due to higher indoor temperatures.

The research aims to quantify the thermal comfort conditions of occupants in PSH buildings with an objective to develop a study that can be used as a reference by the policymakers of the region to proactively promote the concept of PSH houses among the common masses and governmental institutions. The promotion of PSH buildings supported by evidence collected during the project will be disseminated to the stakeholders. Other project components include assessment of innovative building materials, development of replicable designs, capacity building of stakeholders, and evaluation of local building bye-laws.

Mahindra-TERI Centre of Excellence (Mahindra Spaces and TERI n.d.) supports the project by providing credible testing services for examination of the thermal properties of innovative local construction materials used in PSH buildings (HIAL n.d.). With the establishment of the ECBC cell in Ladakh, the sustainability efforts of the UT are observed to be directed towards low carbon development in the region. While the state and central governments aspire towards realizing the goal of a carbon neutral Ladakh by 2050, mainstreaming the construction of PSH buildings and retrofitting the existing ones to PSH in the residential, commercial, military, and other sectors will be a breakthrough step in the sustainable development of the region.

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LOG 9 MATERIALS

Log 9 Materials is a Bengaluru-based deep-tech start-up, offering state-of-the-art batteries ideal for the Indian and other emerging markets. Presently, Log 9 possesses capabilities across materials, electrode, cell, and pack-level fabrication of energy storage technologies. Founded in 2015, Log 9 has used its core competence in material science to create pioneering solutions in terms of utilizing the wonder material 'graphene'. The core principle of the organization is to tackle the chronic issue of climate change while constructing a sustainable and scalable business around the same.

The start-up, first one to be incubated at IIT Roorkee's TIDES, was financed and supported by renowned investors such as Sequoia, Exfinity Venture Partners, GEMS, and ARBL among others. Built out of a lab at IIT Roorkee, Log 9 aims to lead the graphene revolution by introducing in-house breakthrough innovations to the global stage, thereby catalysing India's dream of self-reliance. In its early years, Log 9 created numerous technologies and produced unique product prototypes in a number of sectors, including a revolutionary smoke filter, 'Ppuf' and a novel spill containment material marketed as 'Sorbene'. More recently, the company took a focused strategy to solve the issues in the energy industry in the segments of electric vehicles (EVs), energy storage, and fuel cells. Log 9's newly developed rapid charging battery packs that address the range anxiety by charging within 15 minutes is a sure-shot way to accelerate two/three-wheeler EV adoption, whereas its aluminium fuel cell (AFC) technology is geared towards long haul electric mobility as a zero-emission alternative to diesel generators.

Today, we import vast amounts of oil, but tomorrow, we might do the same with lithium-ion batteries. Instead, Log 9 aims to utilize what is abundantly available at home that offers more user-friendly features, such as refuelling, short refuelling time, lower cost, and longer range. With a major proficiency in graphene nanotechnology, Log 9 (one of the only two companies worldwide) has created emission-free aluminium fuel cells (AFCs) that can power EVs, houses, and industrial equipment. These cells have three primary components including aluminium, air, and water, coupled with a graphene-based innovative air cathode.

Procuring raw materials for AFCs is much simpler than those for lithium-ion batteries, which use lithium and cobalt, thereby drastically reducing the manufacturing cost. Another benefit of such a technology is that the aluminium plates are exhaustive in nature and at the end of their useful life, they turn into an oxidized powder that can be smelted back into its original form. This makes the spent fuel recyclable. An end-to-end zero-waste and zero-emission system supporting the circular economy may finally offer a sustainable answer to our energy challenges. The technology will be proven and commercialized in the next few years by Log 9, initially as a stationary power generating system, followed by vehicle integration with major EV OEMs (original equipment manufacturers) in India. The path to 100% clean mobility will become much easier with AFCs.

While Log 9's rapid charging battery tech focuses on electrifying millions of commercial fleet two-wheelers and three-wheelers that currently run on petrol or diesel, the company's AFCs could be a game changer for long-haul LCVs (light commercial vehicles) and HCVs (heavy commercial vehicles), especially buses, which are extremely difficult to electrify using the standard lithium-ion EV batteries. Going forward, the PLI (Production-Linked Incentives) scheme announced by the government to promote advanced battery cell manufacturing in India will be leveraged by Log 9 for locally producing new battery cell technologies including supercapacitors, high power lithium cells, and AFCs. On the social front, Log 9 seeks to promote a culture of monitoring to curtail carbon footprint. Overall, Log 9 anticipates exponential development for a green and sustainable future.

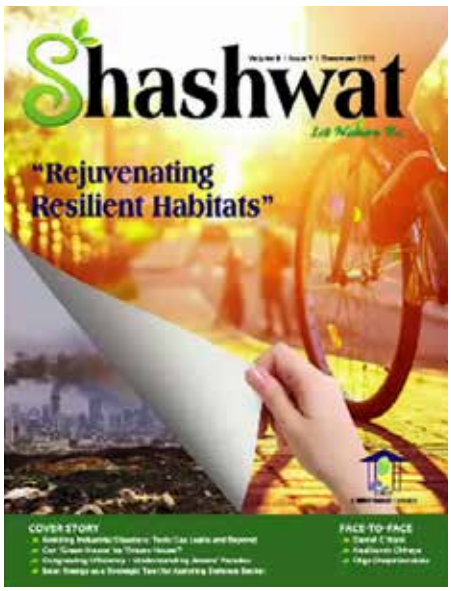
THE 12TH GRI

GRIHA Council released a limited-edition web application called GRIHA REACT (Resource Efficient & Affordable Choice of Technologies). The application features an interactive activity to optimize the resource demand for a virtual apartment.

Shri M. Venkaiah Naidu, Hon'ble Vice President of India, launched three e-publications of the GRIHA Council, namely – GRIHA Version 2019 Manual, Shashwat Magazine, and 30 Stories–Beyond Buildings.

HA SUMMIT

The 12th GRIHA Summit was inaugurated in the presence of Hon'ble Vice President of India, Shri M. Venkaiah Naidu; Minister of State, I/C, Housing and Urban Affairs, Shri Hardeep Singh Puri; and Ambassador of Denmark to India, H.E. Freddy Svane.



The Rating Award Ceremony was held during the valedictory of the 12th GRIHA Summit. A total of 33 rating awards and seven exemplary performance awards were given during the event.

GRIHA RATING AWARD CEREMONY


The Systems View of Life

DR MELISSA STERRY

Specializing in futures in the built environment, design, manufacturing, engineering, utilities, publishing, media and communications, **Dr Melissa Sterry**[1] is one of the world's most high-profile futurists. She has contributed to groundbreaking sustainability innovation projects in Europe/UK, USA, and South and Southeast Asia. She has been felicitated with several national and international innovation, creativity, and enterprise awards, the most notable being the Mensa Education and Research Foundation International Award. In 2004, she created the award-winning sustainability think tank and collaborative-laboratory Societás, which she ran for several years.

» 'Carbonised wood specimen dated to the Upper Triassic from Dr. Sterry's personal collection. One of many items that she used when researching the principles for Panarchistic Architecture, this specimen is a record an ancient forest fire'

In this conversation with GRIHA Council, **Dr Melissa Sterry** discusses the threats posed by climate change and global warming, the relevance of local indigenous knowledge, the need for urban resilience and sustainable architectural practices, the implications of nanoplastic pollution on marine life, and more.

[1] For more details, visit www.melissasterry.com

GRIHA: How do you think existing cities in developing countries like India can adapt to challenges such as climate change and rapid urbanization?

» 'One of many specimens of both extinct and extant Pinus and other plant specimens in Dr. Sterry's personal collection, the functional traits of this pinecone are expressed in the principles that define her Panarchistic Architecture paradigm'

MS: The sum of science makes it clear that we are on the worst-case climate change trajectory. Though the implications of this situation are profoundly serious, they are still more serious because human actions, be it unsustainable resource use, biodiversity loss, or nano/micro plastic pollution, are burdening our environment.

The most commonplace mistakes we are witnessing both within and beyond the built environment professions are, first, an absence of diligence in researching the complexities of climate change, wherein many researchers and practitioners are relying on already outdated and siloed data. Second, we are seeing far too many architectural and urban design proposals that treat addressing climate change as a singular issue. For this reason, while a lot of proposed ideas are intended to lower carbon emissions, they fail to address and in some cases aggravate other critical environmental and social problems. Third, there are far too many projects that expect too much from too little, such as those that afforded scant time and expertise. These projects rely on superficial research and inadequate due diligence. Consequently, concepts that are at best second-rate and at worst deeply flawed get presented. Such flawed projects are often given undue visibility by the press and media. This being a symptom of quantity over quality content and strategies built on click-based revenue models, as well as awards, programmes and even grants that, likewise, laud problematic projects because they fail to subject applications to robust examination.

Hence, if meaningful and effective progress is to be made on the problem of adapting to climate change, and to environmental challenges at large, we need far more considered and strategic approaches to designing and managing the processes that facilitate that task. The fact that the default modus operandi of many professionals, and in turn sectors, has been working in silos, it's questionable as to how easily this could be remedied. However, regardless of when, or indeed even 'if' we witness a transition towards a more joined-up thinking, there are things we can do now to help our cities adapt to the changing environment.

The foremost factor in how communities, whether urban or otherwise, prepare for the challenges ahead is that of tailoring their plans to the *specific* environmental and social conditions of their locale. There are no one-stop-shop solutions and understanding the unique features of a locale necessitates bringing the widest range of expertise together. The expertise must extend across areas including, but not limited to the following:

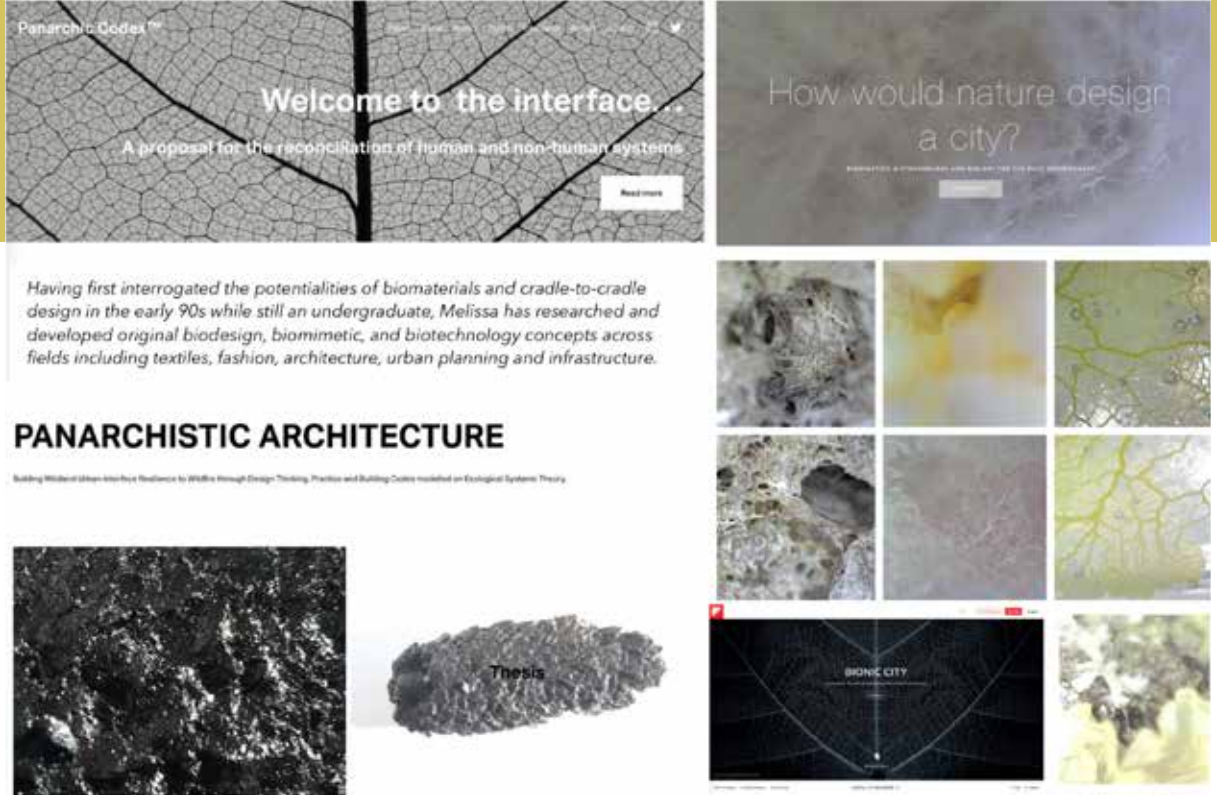
Earth Sciences: The past, present, and likely near-to-medium term meteorological, geological, biological, and other systems must be assessed to their full extent. The interdependency of these systems must be factored into every planning proposal, from the scale of a building to a city.

Local indigenous and vernacular knowledge: Ancient methods of land-use management and construction are products of a region's shifting environmental conditions over several millennia. Profound insight resides in these traditions, and their potential applies not merely to the historic practices alone, but to the application of their underlying principles to new works too.

Wider expertise in local culture, beliefs, and values: Solutions to environmental problems should accommodate the emotional and practical needs of citizens. No matter how technically efficient an idea is, it will fail to gain the support of local communities if it is at odds with the things they value most. By engaging local community leaders, artists, educators, and others who know the emotional values of the people of a place; architects, urban designers, planners, and policymakers can ensure that their proposals are appropriate.

Representatives of the community at large, and across every demographic: Every gender, age group, ability group, etc., must be represented (equally). More voices and views help shape a built environment proposal that is likelier to accommodate the needs of all. The built environment professions remain male-dominated because of which many architectural and urban design proposals fail to address even the basic needs of a larger demographic.

By bringing the earlier listed expertise to the table, built environment researchers and practitioners can ensure that most workable solutions are delivered. It's important to note that although integrating global knowledge is essential, cities are designed using local knowledge.



GRIHA: Can you tell us a bit about Bionic City®?

MS: In its first incarnation, Bionic City®[2] was an imaginary 'super' city, a concept birthed in early 2010. It explored the idea that we can create stronger urban resilience through the mimicry of species that have evolved to coexist with major natural hazards of the ilk of eruptions, earthquakes, floods, hurricanes, and more. During my PhD research, while also consulting with industry on hazard resilience and sustainability in the built environment, the Bionic City® was, in effect, an avatar, (in that, it was never intended to become a real city, but a virtual entity) that helped us understand the potential of novel ideas. Taking inspiration from various artistic sources, I used the Bionic City® to tell the story of nature-inspired cities that could exist in the future. In the first instance, I had no idea how wide its appeal would be, but the idea resonated with a far wider community than I had anticipated. Before I knew it, I was being asked to give keynotes on the concept and to write several cover stories for national and international magazines.

By 2012, I started thinking about how this imaginary biomimetic-city might work by not only integrating my own architectural and urban ideas, but those of the wider research community. Hence, when authoring publications about the city, I started to reference how the work of my peers might feature in its workings. In 2013, I mentioned the magazine, which was then on a private-setting, to a peer who expressed interest in perusing it, so I switched the magazine setting to public. By 2014, the magazine, which I had called Bionic City®, had over 100,000 followers and over 3,000,000 content shares. At some point in the future, I might develop the publication so that it doesn't merely curate works, but features original articles too.

Soon, Bionic City® evolved from being a city-avatar-cum-curation platform to a bioresearch lab, consultancy, and collaboration platform. At some not-so distant point, it will evolve again. However, the intention will always be to fill a knowledge gap. Hence, true to the nature of nature itself, its state is ever-changing, not fixed.

» 'Coal specimen from Dr. Sterry's personal collection of geological materials. Her Panarchistic Architecture paradigm involving the cycling of building materials from the molecular to the city-scale, her proposal is for architecture synced with the rhythms of the natural world, from the changing of the seasons, to wildfires and other hazard events, to shifts in the climate, and whole geological epochs'

[2] For more details, visit www.bioniccity.co.uk

GRIHA: How can nature inform the design of cities?

» 'Fossilised tree specimen dated to the Miocene from Dr. Sterry's personal collection. Earth transitioning out of the Holocene and into a new epoch, when researching the cyclicality of wildfire, Dr. Sterry examined the fire record from its advent on Earth in the Silurian, some 420 million years ago, including examining how species that have evolved to coexist with wildfire have evolved over time'

» 'Carboniferous fossil specimen from Dr. Sterry's personal collection, which records a forest fire so ancient that the continent it took place on no longer exists. Though today's wildfires are more extreme than witnessed in living memory, they are many times less fierce than the wildfires that raged in some epochs of past. Dr. Sterry's Panarchistic Architecture paradigm imbues architecture with the functional traits that have enabled some of Earth's foremost resilient plants to persist through the many and fierce fire ages of past'

MS: The ways in which nature can inform cities are numerous, diverse, and profound in their implications. We now understand that diversity spans not one, but many 'bio-prefixed' fields, including biomimetics, biodesign, biotechnology, biosensing, biocomputing, biomaterials, biomanufacturing, and more. Though these fields share some common ground, such as the general character of the information and the material systems they create, they are nonetheless distinct. For example, though all involve scientific enquiry, the extent varies significantly. While some fields can be pursued using low-tech methods and little expertise, such as the growing field of biomaterials, others require highly specialized knowledge and an array of state-of-the-art technologies, such as biosensing when applied at the scale of buildings and landscapes.

But, fundamentally, the lessons we have to learn from nature involve observations made over space and time – understanding why and how flora and fauna, and the ecosystems they form, change in response to shifts in their environment, such as changes in lighting, temperature, and humidity levels through the day, seasons, and geological epoch, among other things.

The beauty in these lessons is that the workings of the non-human living world are the product of innumerably more experiments than it will ever be within human capacity to undertake. We may never have the ability to recreate the wide-ranging conditions that shaped life on Earth over hundreds of millions of years. What we can do is study the results and solutions of how the species evolved to cope with the conditions they encountered. When I say, 'solutions', I reference not only the physical solutions, i.e., the things that are encoded into a species' genetics, but also, their cultural solutions, because like humans, both animals and other living species survive through sharing of information.

Of course, those with an interest in anthropology and archaeology, among other fields, will know that humans have been learning from nature all along. This is not only clear in our earliest written records, but in the rituals, myths, and artefacts too that predate writing. Although this evidence is scattered across ancient human sites worldwide, India is home to some compelling examples. When we look at the stories our ancestors handed down to us, we find correlations between not only the structure of these stories, but the meaning too. Some ancient myths reveal a deep understanding of environmental issues, both at the level of individual species, i.e., their origin, and of systems, i.e., how ecosystems respond to environmental changes. I have discussed this topic at length in a chapter in my PhD thesis and several lectures, in which I presented how and why both the *Origin of Fire and Tree of Life* 'myths' align with scientific facts. Thus, indigenous knowledge systems have a central role in enabling us to understand the world around us. Harnessing that knowledge involves respecting the fact that information can be recorded in diverse ways, not just scientific papers, industry reports, and

news opinion pieces. An example of how this knowledge can be applied was a collaborative project I undertook with the Indian artist Kavita Singh Kale in 2014. We worked together to explore the future city through the lens of Indian ecology and ecological beliefs and systems, focusing on the *Tree of Life*. Our project having initially concluded with an exhibit at India's National Institute of Design, in concert with a poster campaign and public mural, Kavita developed the work further to create a children's book for the United Nations that illustratively communicated the Sustainable Development Goals.

So long as the integrity of the scientific enquiry is sound, and the project has something new to add to the local and/or global conversation, there are endless ways in which the study of nature, and our relationship with it, can inform and inspire our current and future cities. India is, in some ways, more advantaged than some other parts of the world, in that, its cities are still populated with architectures, whether temples, stepwells, or more, physically record the knowledge of our ancestors. Some believe that our ancestors can be called upon to help us in difficult situations. Whether we can, or we can't commune with the deceased, one thing we can do is study their architectures, their paintings, their myths, and everything else they left behind to find solutions to our problems.

One of the things India's 'nature mythologies' makes clear is how our understanding of the construct of 'nature' changes over time. The term means different things to different people at different times. Various factors shape that understanding, not just the extent to which we are able to see the processes of nature in action. Every passing day brings a new discovery in how the non-human world works. It is evident from the teachings of many ancient Indian belief systems that for ages, people of the region diligently observed the natural world, and having done so crafted their values accordingly. Millennia later, we're still doing that.

GRIHA: How might we, as citizens, work towards adapting to these changes?

MS: The implications of climate change, and of the environmental and social challenges we face are frightening. How people perceive these implications varies depending on their psychology and ability to deal with change. I have hypothesized that we humans approach problems differently because we are social creatures that have evolved to tackle problems in teams, as opposed to working through issues on our own. If my hypothesis is correct, our individuality is an evolved functional trait designed to increase our odds of survival. Over time, this trait has become more distinct and diversified in its expression. The upside of this diversity is that it makes our lives immeasurably more interesting than they might otherwise be, many minds being better than one at solving problems. The downside is that because we have evolved to think differently, we don't always agree. The challenges of climate change present umpteen issues and the inability to agree on them is problematic. But, if we are to stand a reasonable chance of finding solutions to the immense challenges, we must find a way to agree on more, and to do that we must listen more, think more deeply, and reflect on where we are prepared to make compromises.

Though we don't have all the scientific, technical, and engineering answers we need yet, we are not far off. Hopefully, by the time we do have those answers, humanity would have found a way to get along at least a bit better than at present. If we can, it could be the difference between our collective success and failure on every issue that really matters. Specifically with respect to the built environment, India and many other developing nations are home to some of the most sophisticated climate-resilient indigenous and vernacular architectures in the world. Approaches to design, construction, and materials

that researchers and practitioners in the developed world often imagine to be new, have been in use in the Global South since the Bronze Age, and earlier. India, among other countries, offers thousands of examples of vernacular techniques for rainwater harvesting and design of passive houses and more used by our ancestors. In some cases, these methods still remain fit for their intended purpose in their original form. In other instances, the general principles retain their integrity, but aspects of their materiality must be updated. The fact that many ancient buildings still withstand innumerable natural hazards – be it earthquakes, floods or heatwaves – bears testimony to the integrity of the architectural design. And when we think of sustainability, we must go beyond human needs and be considerate to the needs of other species too.

GRIHA: Business and individuals have suffered a great deal due to the COVID-19 pandemic. As we look towards restarting business, what are the ways in which we can sustainably restore or reform economies?

MS: Building sustainable economies starts at the level of individual businesses. Of these businesses, some of those with the greatest agency to pioneer ways to live and work more sustainably are innovation-led start-ups and small to medium-sized businesses. Earlier this year, I authored an open access report titled, 'Innovation Against All Odds',[3] designed to help businesses understand the key issues they must consider as we restart, restore, and reform. The work integrates expertise from thought leaders from different fields of industry, commerce, and academia. The report lists key questions and considerations that businesses need to ask, and it explains some of the seminal trends that are shaping the leading edge of industry and society-at-large. It also shares a list of reading materials for a better understanding of various subjects.[4] Though principally authored for those running businesses, the considerations and questions the report recommends are applicable at the level of policy and regulation as well. Currently, and across almost all domains, the rules governing how we do business are inadequate from a sustainability perspective. The reason for the inadequacy is the fact that they simply don't accommodate the pertinent issues. The consequences of these inadequacies for the environment and society are serious and related to the built environment.

There are many lessons that both businesses and society could learn from the COVID-19 pandemic. From 2017 to late 2019, I discussed the near-future threat of pandemics in several keynotes and publications. I warned that science was clear that the probability of a pandemic was high, and the implications significant. The reason I was able to foresee the risk was because every factor that increases the probability of a pandemic outbreak was in play. On the one hand, humans are increasingly encroaching on places where pathogens both known and novel are present. When encroaching on these places, humans are increasingly engaging in activities that bring them into direct contact with animals that host these pathogens. Additionally, climate change and other environmental shifts are causing pathogens to move, be it because host species are changing their territories in response to environmental changes, or because mechanisms triggered by climate change, such as changes to soil hydrology, are causing the release of pathogens into the atmosphere. On the other hand, once established in a human population, pathogens can spread faster. For that reason, the pandemic we are experiencing now is, in my expectation, the first of several, but of which the causes may vary. However, be they viral, bacterial, or other pathogens, the ways in which humans can limit their spread among populations are the same. Every tactic that's been engaged to try and combat the current pandemic has relevance to the control of future pandemics.

Many were mistakes made in response to the handling of the current pandemic, and with tragic consequences. Therefore, we should learn from those mistakes and build resilience to the threat of future pandemics. How we design our buildings and urban spaces lies at the heart of mitigating the threat of pandemics. This is why it is critical that every public space or communal area is designed in a way that integrates means of mitigating the spread of pathogens, such as ensuring ventilation and adaptability of spaces where areas can be made more open or closed with ease.

[3] For more details, visit https://issuu.com/melissasterry/docs/innovation_against_all_odds_report_8427e1fad79f81

[4] For more details, visit www.openforesightseries.com

GRIHA: You have donned many hats – from being the founder of Bionic City® to becoming a prolific author, scientist, designer, and academician among others. What would be your advice to women in sustainability who are looking to take on similar leadership roles?

MS: Some of the challenges that women face as leaders are generic, while others are site- and context-specific. Having held executive-level roles across several industries and professions, I've found significant differences in the way women are treated more generally. Some of the commonalities in the issues they face across industries are (as follows):

Pay inequality: Ways that help a woman to address this issue are, first, researching the pay of male peers with like-for-like or similar experiences. Second, if you are able, be prepared to walk away from salary/fee offers that are lower than your commercial value. In my experience, the built environment is one of the worst sectors for pay parity, but the likely causations aren't linear and are a cumulation of poor industry habits.

Continual acquisition of new knowledge: Sustainability is a highly complex issue which doesn't exist in a vacuum. Instead, every sustainability issue is tied to multiple other issues. It takes decades to gain an understanding of sustainability in its widest context – to realize how all the different issues fit together. Making matters more complex is the fact that recent and emerging fields of scientific enquiry are revealing more sustainability challenges, and some of these are not fully understood, let alone quantified. One such example is the extent of nanoplastic pollution and its implications on the land and marine species worldwide. Consequently, unlike some professions, a role in sustainability necessitates continual acquisition of new knowledge. Networking with knowledge experts from different fields and facets of sustainability can help address related issues.

Building a strong support network: Last but not least, I advise any woman who seeks to pursue a leadership role of any kind to build a strong support network around her, which should include, among others, mentors both specific to her field, and more generally, experts from other fields too, who, though external to her own, would be central to how private and public organizations operate. Above all, to succeed in leadership, a woman needs trusted allies that she can turn to when faced with difficult choices and situations.

GRIHA: The IPCC (Intergovernmental Panel on Climate Change) 2021 report[5] has established links between human activities and climate change. What role do you think mainstreaming environmental sustainability in pedagogy and practice can play in being better prepared for climate change risks?

MS: Perhaps, the best way of framing this answer is to consider the consequences of 'what if we don't'. I have been researching the subject of climate change since the late 1980s; however, it wasn't until the mid-2000s that I fully understood just how serious the situation before humanity was. The first event that enabled that realization was a series of discussions with a scientist peer who had built a software programme that modelled the last several hundred years of Earth's climate. Essentially, the programme served as a lens on what variables catalyse what changes in the climate. Just as the programme was able to model past climate (conditions), it was able to make calculations on future climate. Together, we discussed the implications of what the data generated by the programme told us. We triangulated that data with other data on how changes in the climate of the past had shaped extinction and evolution events, and with them, changes on Earth – for instance, how changes in the climate impacted geological activity and regional hydrology.

In the same period, I was part of a climate change think tank, whose objective, among other things, was to understand why humanity was not responding at speed and scale to the threat of climate change. The think tank comprised scientists, psychologists, anthropologists, environmental scientists, and communications experts. Of the many activities we engaged in was a frank discussion

[5] For more details, visit https://www.ipcc.ch/report/ar6/wg1/

on the anticipated implications of climate change according to the latest data. Many professionals hope that their analyses are correct, but in this case, I hoped that mine were wrong. Years on end, the data coming in from multiple studies around the world pointed to the fact that Earth's climate was transitioning to what constitutes the worst-case scenario for humans and for most other macro life forms on land and in the sea.

My response was to ask, 'How best can I help?' Prior to 2007, my work in sustainability was spread across several sectors, but I eventually decided to focus on the built environment. Currently, there is not a city that is prepared for what is coming. Time is more precious than ever. If we are going to tip the odds in our favour – and that of the millions of species whose fate lies in our hands – we need to use what time we have very wisely.

GRIHA: Recent wildfires that occurred in America and Australia have given rise to serious concerns for both wildlife and humanity. How can Panarchic Codex® help us be better prepared for such challenges in the future?

MS: Panarchic Codex® is a proposal for the reconciliation of human and non-human systems at the interface of fire-prone wild and urban lands. The proposal is hosted on an open access website,[6] which I have created to host both my transdisciplinary PhD thesis, 'Panarchistic Architecture: Building Wildland-Urban Interface Resilience to Wildfire through Design Thinking, Practice and Building Codes Modelled on Ecological Systems Theory', together with more recent publications, podcasts, lectures, e-books, and works including interviews with world's leading experts from both the fire sciences and other relevant fields. The name Panarchic Codex® relates to the speculative building codes I authored to convey how the Panarchistic Architectural paradigm might work in policy and wider practice. Upon the decision to make both the thesis and the post-PhD research accessible to the public-at-large, I applied the name Panarchic Codex® to the project in its entirety.

The Panarchistic Architecture paradigm explores the possibility of building better resilience to wildfires through the creation of architecture and urban systems that mimic the biochemistry, behaviours, and relationships of flora and fauna species that have evolved to coexist with wildfires. The paradigm proposes that these built systems are not homogenous, but heterogeneous. For this reason, there is no one type of wildfire, but several, each of which presents specific challenges to buildings and other built structures. Unlike many biomimetic studies, the proposals I have made are not a product of generic assumptions about how plant species – and nature more generally – work, but of study of several species, and of the ecosystems of which they are a part. Essentially, the paradigm is a knowledge-transfer exercise, where I have identified the traits that enable some plant species to persist in the presence of wildfires. I have also suggested ways how emerging and anticipated near-future breakthroughs in fields including materials science, computing, engineering, and more, could enable the creation of peri-urban and urban spaces that do not behave like buildings, but plants. The proposal rejects the notion that it is good enough, or even appropriate to pass placing potted plants on balconies as 'sustainable', instead, it reimagines the core functionality of that which we build. The paradigm rejects the idea that we should perceive resilience as the ability to endure any natural hazard event, instead, highlighting that resilience comes in different forms, each of which must be tailored to the nature of the hazard. Though the wildfires of the western United States and of Australia have attracted most attention, the problem of living with wildfires extends across many other nations, of which several are in the developing world. Hence, though the initial focus of my research was on the wildfires specific to the western United States, the later works examine wildfires in other regions and in contexts beyond the wildland urban interface. Having studied the potential of creating biomimetic-resilient strategies to (manage) wide-ranging natural hazard types, I realized that the threat of wildfires was scaling faster than the solutions to the problem. Having researched the *Origin of Fire* myth of India during my PhD research, I hoped to explore the evolution of our relationship with fire. As Einstein famously said, we can't solve a problem by approaching it in the same way that caused it. The scientist in me soberly questions if humanity can overcome the challenges ahead. But the creative in me says, we can and we will, be it reinventing our relationship with wildfires, with the environment, or perhaps, more profoundly still, with ourselves.

[6] For more details, visit https://issuu.com/melissasterry/docs/innovation_against_all_odds_report_8427e1fad79f81

ECO ECLECTIC TECH

Dr Binish Desai, aka India's Recycle Man, began his recycling journey when he was just 10 years old. At the age of 11, he started creating bricks with chewing gum and paper. In 2016, he started his company to make eco-conscious products. Today, he converts waste into eco-friendly products. As part of his social innovations, he has created more than 150 products – crockery, bricks, home décor, and jewellery – out of different types of waste.

Dr Desai recounts his journey with us. Captain Planet and Dexter were my childhood favourites and my sources of inspiration. I was 11 when a chewing gum got stuck to my pants and I tried removing it with a piece of paper. The gum eventually hardened and that piqued my curiosity, so I went back home and repeated the same experiment. That is how the idea of making bricks took shape.

In 2010, when I was 16, I founded BDream (now Eco Eclectic Tech). In 2016, the company was renamed with a broader vision. Premised on the principles of sustainable design process and core design philosophy, my company believes in the concept of triple bottom line (TBL), where all our products are created based on the philosophy of a sustainability model, thereby striking a balance between social impact, environmental impact, and economic viability. Using this along with our circular economy model, we have a special process of converting waste into eco-friendly assets. Our three-step process involves identification of the waste and its origin, segregation and collection, and eco-processing, which further involves decentralized systems, where instead of having just one big factory, we work with multiple factories in rural areas across India to empower women.

We believe in redefining waste through our company like Ida Eco Décor, where the women convert waste into beautiful crockery and home decor products. Our work includes developing technologies that convert waste into eco-friendly products, such as brick 2.0 from PPE and paper mill waste; paver blocks from metal and textile wastes; artificial wood from Ayurvedic waste; and so on. The identification of various wastes and their sustainable solutions for recycling and management for commercial establishments, industries, societies, and government bodies are other objectives of our company. Next, we aim to create a zero-waste circular solution for the movie and wedding industries as well. We also wish to establish women empowerment centres to provide employment opportunities to the marginalized.

We work towards creating eco brands for crockery, corporate gifts, and home decor products – all handmade from waste. Sustainable marketing consultancy is another area that we work in to bring eco-friendly projects. The process of brick 2.0 involves making bricks that need 7 kg biomedical waste per square foot. These bricks are three times stronger than conventional bricks and are twice the size and half the price. At the beginning of manufacturing these bricks, our team places 'eco-bins' in different locations, such as hospitals, police stations, and bus stops. These eco-bins help collect PPE and face masks. Since these bins come with an indicator at the side, we get to know when the bin is filled up. Once the bin is full, as per the Central Pollution Control Board (CPCB) guidelines, the material is kept under isolation for 72 hours before being taken to the factory/manufacturing plant. Once it reaches us, the material is disinfected, shredded, and disinfected again before being added to the paper mill waste and binder. Further, it is moulded into the desired size of the brick and eventually dried naturally.

In terms of our engagement with stakeholders, each one assumes responsibility towards waste reduction. While consumers must make informed decisions while buying products and reducing waste generation, the manufacturers too should opt for a more sustainable and circular approach. The community of recyclers like us must authentically recycle the materials into eco-friendly products that will ensure ecological sustainability. India is a leading solution provider of zero-waste technologies, where we can all make locally and sell globally, and where nothing is considered useless. What is waste to you could be someone else's asset.

Indian Institute of Management Nagpur, Maharashtra

Dr Bhimaraya Metri
Director, IIM Nagpur

"The master plan of IIM Nagpur's state-of-the-art campus–spread over 132 acres in the heart of MIHAN (Multi-modal International Cargo Hub and Airport)–has been designed as per GRIHA LD (Large Development) rating, considering a resource efficiency approach throughout the development process to achieve United Nations' goal of "sustainable development and climate change mitigation with lesser impact on the environment.

IIM Nagpur is thankful to GRIHA Council for appreciating its efforts."

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