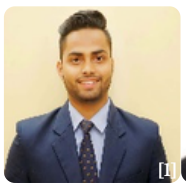
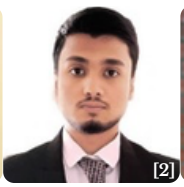
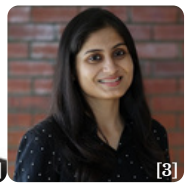
India's Infrastructure: A Concrete Jungle or a Climate Asset?


[1]

[2]

[3]

KID: 20250213

India's urbanisation is accelerating at an unprecedented pace. By 2030, over 600 million people will inhabit its cities, placing immense pressure on already stretched infrastructure and resources. Buildings alone account for around 35 per cent of India's total electricity consumption, a figure set to rise sharply as cooling and lighting demands increase. Yet, despite receiving more than 300 sunny days annually and holding a theoretical solar potential of 750 gigawatts, rooftops, facades, and highway structures remain passive and under-utilised surfaces.

Imagine this: if just 50 per cent of India's solar potential were harnessed, the country could generate approximately 590 billion kilowatt-hours each year. That's a saving of nearly ₹3 lakh crore or 35 billion US dollars annually in electricity costs. However, the absence of integrated and scalable models prevents these savings from becoming a reality.

The implications are serious. Residents face rising electricity bills and worsening air quality. Cities suffer from intensifying heat islands, frequent grid stress and a stark lack of green spaces. Government agencies juggle between energy security and climate goals while infrastructure developers struggle to implement sustainability in practical and cost-effective ways. Climate change is set to exacerbate these challenges further, threatening public health, liveability and economic productivity.

Reimagining Concrete as a Climate Solution

We believe India's vast concrete landscapes from rooftops to metro piers can be transformed into productive, green and energy-generating assets. One of the approaches integrates three proven technologies:

India's Infrastructure: A Concrete Jungle or a Climate Asset?): Rooftops, facades and windows converted into seamless solar energy generators without occupying additional land area.

Building Integrated Agrivoltaics (BIAV): Rooftop solar systems combined with shaded greenery or micro-farming, optimising land use and improving building thermal comfort.

Vertical Farming Architecture: Hydroponic vertical farms installed on building walls, highway piers and metro pillars to enhance greenery, food resilience, urban aesthetics and cooling.

Why This Matters

Our solution benefits multiple stakeholders:

- Residents through lower electricity bills and improved indoor comfort.
- Developers and corporates by enhancing ESG performance and asset value.
- City governments and Smart City Missions to meet clean energy and climate goals while improving urban aesthetics and liveability.
- Highway and infrastructure authorities by converting idle surfaces into productive climate assets.
- India as a whole by progressing towards its Net Zero 2070 commitments with scalable, distributed solutions.

Learning from Singapore

Singapore, for example, has successfully integrated vertical greenery and solar technologies into its dense urban fabric. The iconic Punggol Digital District uses building-integrated solar panels and vertical gardens to save millions in energy costs while enhancing urban cooling and aesthetics. This model has proven that green infrastructure is not merely an environmental commitment but also an economic imperative.

Then what can be the potential implementation we can do?

India has set an ambitious target of reaching Net Zero by 2070. Although that milestone feels distant, the urgency is already mounting, especially in our villages and smaller towns, where energy access remains volatile and climate impacts are felt most acutely. Relying on any single technology won't suffice. Instead, we can deploy a three-pronged model backed by decades of academic and field research that ensures practical feasibility, climate resilience and strong economic returns:

Consulting & Retrofitting

Assessment of existing structures from residential rooftops to commercial façades, highways, and metro piers should be prioritised to identify opportunities for rapid conversion into energy-positive, green-integrated assets.

This includes energy audits to benchmark current consumption, structural evaluations for load-bearing capacity, and thermal comfort analyses to map how agrivoltaic shading and vertical greenery can reduce cooling loads.

"India's urbanisation is accelerating at an unprecedented pace. By 2030, over 600 million people will inhabit its cities, placing immense pressure on already stretched infrastructure and resources. Buildings alone account for around 35 per cent of India's total electricity consumption, a figure set to rise sharply as cooling and lighting demands increase"

New Construction Integration

Architects, engineers, and contractors can embed these core technologies from the design stage itself:

BIPV modules integrated into roof membranes, curtain walls and even window glass, harvesting sunlight without sacrificing aesthetics or usable floor area.

BIAV systems that combine elevated PV canopies with hydroponic planter boxes or modular micro-farms, generating electricity while cultivating crops that **improve air quality and add revenue streams.**

Vertical farming architecture using lightweight, stackable growing racks affixed to exterior walls and pillars, bringing fresh, hyperlocal produce to dense urban corridors.

Precast Modular Products

To accelerate deployment and minimise onsite construction delays, Indian steel and infrastructure industries could focus on manufacturing prefabricated sustainable pods and panels that snap together like building blocks. These could include:

> *"India has set an ambitious target of reaching Net Zero by 2070. Although that milestone feels distant, the urgency is already mounting, especially in our villages and smaller towns, where energy access remains volatile and climate impacts are felt most acutely"*

- **Solar-Integrated Office Pods & Cabins** for remote government offices or defence outposts.
- **Compact Solar Homes** for affordable housing projects, complete with pre-installed BIPV façades and rainwater harvesting systems.
- Scalable Agrivoltaic Panels designed to clip onto highway noise barriers or metro viaducts, instantly greening and powering miles of concrete infrastructure.

Each of these approaches has been validated, from energy yield studies at Fraunhofer Institute to agrivoltaic trials at Wageningen University, suggesting a holistic, future-proof pathway to transform India's built environment into a network of productive, green and energy-generating climate assets.

Impact Potential

Utilising just 10 per cent of India's urban rooftop area for BIPV could add nearly 60 gigawatts of solar capacity, generating about 95 billion kilowatt-hours annually. This is equivalent to saving 47.5 million tonnes of coal and avoiding 85 million tonnes of CO_2 emissions each year. Additionally, each square metre of vertical farming can yield 40–50 kg of vegetables annually without occupying any ground space.

A Call to Action

It is time we stop seeing India's infrastructure merely as concrete jungles. With the right vision, technology and implementation, we can reimagine every rooftop, facade and highway pillar as a climate asset, ensuring clean energy, food resilience, economic productivity and a liveable future for all.

[1] Mr Mohsin Siddiqui
MTech, Dept of EM
[2] Mr Syed Zain Ahmed
MTech, EST, Dept of Greenko School of Sustainability
[3] Dr Jayshree Patnaik
Assistant Professor, Dept of EM