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Whitepaper on

Scaling up Building Integrated Photovoltaics (BIPV) Applications in India

Preliminary Stakeholder and Panel Discussion

GRIHA

THE ENERGY AND RESOURCES INSTITUTE

Creating Innovative Solutions for a Sustainable Future

Acknowledgements

We acknowledge the contributions of individuals and organisations involved in the development of this white paper, "Scaling up Building Integrated Photovoltaics (BIPV) Applications in India."

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Contents

Executive Summary

Overview of the White Paper

This white paper is a precursor to examining the potential for scaling up Building Integrated Photovoltaics (BIPV) in India, informed by preliminary stakeholder and a workshop entailing international experience and a panel discussion that engaged representatives from government agencies, architects, commercial space developers, and BIPV specialists. These dialogues provided insights to align international expertise with India's unique challenges and opportunities. BIPV, which integrates renewable energy generation with functional building elements, is a novel concept, offering incredible potential to achieving India's green building and energy efficiency goals.

Key Highlights from Panel Discussions

- **Energy Transition and Urban Resilience:** BIPV was recognised as an innovative PV integration approach in decentralising power generation, reducing grid inefficiencies, and turning underutilised building surfaces into energy generators. Its role in enhancing urban energy resilience was emphasised.
- **Policy and Market Readiness:** The absence of BIPV in key government standards and housing schemes was identified as a barrier. Recommendations included integrating BIPV into public sector projects, offering tax incentives, and promoting public-private partnerships.
- **Architectural Integration:** BIPV's adaptability to various styles, including modern and heritage buildings, was highlighted. Customisation options like colour matching and textures are essential for wider adoption.
- **Technological Innovations:** Advances in vacuum coating and translucent materials were discussed, showcasing BIPV's potential to improve aesthetics and energy efficiency.
- **Economic and Employment Opportunities:** Scaling adoption can reduce costs through economies of scale while creating skilled jobs in manufacturing, installation, and maintenance.
- **Barriers to Adoption:** High upfront costs, awareness gaps, and technical challenges such as dust accumulation and shading were identified as critical hurdles.

Recommendations

- **Education and Awareness:** Conduct workshops for architects, developers, and policymakers. Implement demonstration projects to build confidence in BIPV technology.
- **Research and Development:** Foster academia-industry collaboration to design climate-specific BIPV solutions. Develop tools and calculators to quantify BIPV benefits, supported by organisations like IIA and GRIHA.
- **Pilot Projects:** Test BIPV performance in diverse urban and climatic zones. Launch government-supported pilots to set benchmarks and drive adoption.
- **Innovative Financing Models:** Create business models highlighting benefits beyond energy savings. Provide lifecycle cost calculators to illustrate long-term financial advantages.

Context Setting for BIPV

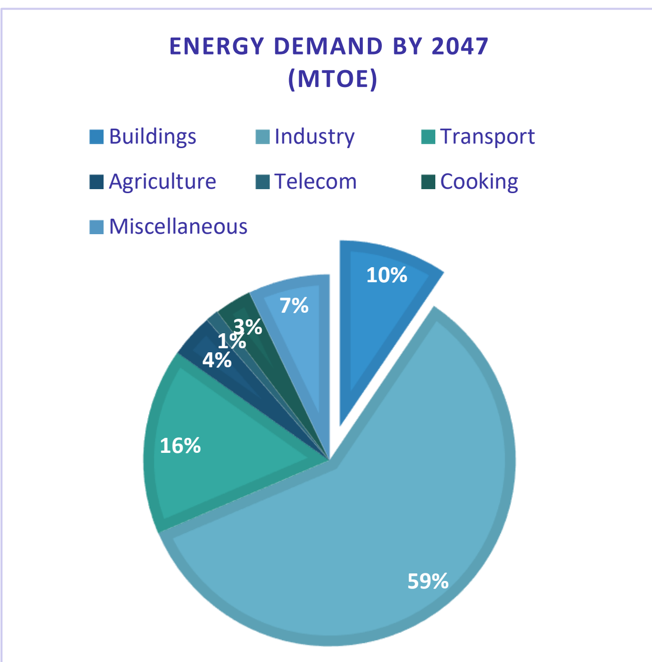
Need to Decarbonise the Building Sector

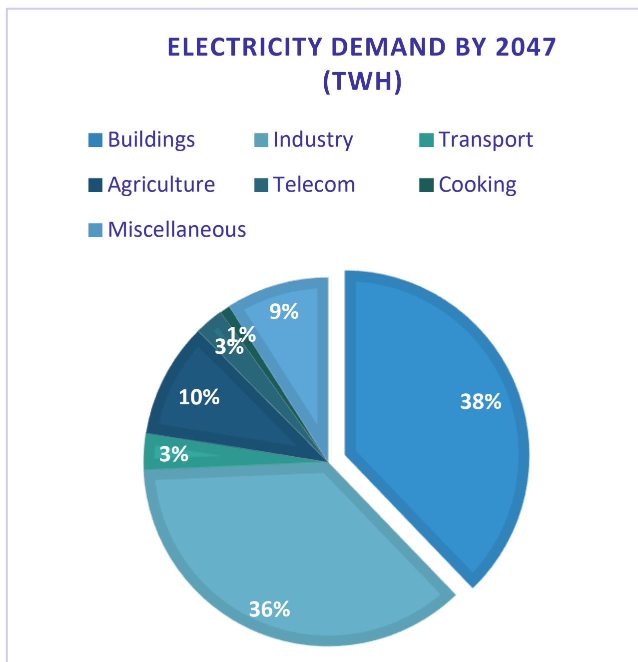
By 2030, over 40 percent of India's population is projected to reside in urban areas.[1] Residential buildings account for ~24% of total electricity consumption in India, and this sector is set to experience significant growth over the next two decades, with an estimated addition of around 3 billion square meters by 2030.[2]

India is on a critical quest to becoming a trailblazer in clean energy, paving the path to achieve 500 GW of non-fossil installed capacity by 2030. The projected capacity addition for solar energy—a front runner in India's clean energy mix— to meet the demand during the period 2027-2032 is 179 GW, leading to ~365 GW of solar capacity by that period[3].

As air conditioners and other appliances become more common, the electricity demand from the building sector will increase significantly, potentially making it one of the largest electricity-consuming sectors. By 2047, the building sector is estimated to account for around 10% (208.17 Mtoe) and over 38% (2421.07 TWh) of the energy and electricity demands respectively[4].

Given that the journey towards net zero will only be realised through reducing emissions of carbon-intensive sectors like buildings, India needs alternative solutions to build net zero buildings of tomorrow.





[1] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2042542
[2] https://cea.nic.in/wp-content/uploads/irp/2023/05/NEP_2022_32_FINAL_GAZETTE-1.pdf
[3] National Electricity Plan, 2022, Central Electricity Authority (CEA)
[4] India Energy Security Scenarios, 2047

Solar Skyscrapers: Effective Utilisation of Building Space using BIPV

BIPV is an approach where conventional building components (e.g., roofs and facades) are replaced by multifunctional parts of the building skin integrating PV to generate electricity while maintaining structural functionality. Instead of typical rooftop solar structures that require frames for mounting conventional solar panels, BIPV is directly integrated into the building structures, replacing conventional construction materials.

Basis the existing building stock, the potential of BIPV has been estimated to be over 309 GW[5]. It has numerous benefits and application potentials, as demonstrated in international markets[6], including enhanced noise protection (up to 25 dB sound reduction), thermal insulation for heating and cooling, alongside improved aesthetic quality. It also provides electromagnetic shielding, safety features like safety glass, and passive solar shading, which can reduce a building's thermal load and cooling requirements. Additionally, BIPV systems can improve energy efficiency through rear ventilation and proper orientation for maximum solar exposure[7].

Role of BIPV in India's Green Building Sector Growth

India's building sector is poised for sustained growth, with a 9% share of the construction sector in the sectoral composition of Nominal Gross Value Added (GVA) in FY 2023-2024[8], supported by the Government's emphasis on infrastructure development[9] and driven by moderation in raw material prices. High-rise commercial buildings, which are a growing trend, inherently feature a higher ratio of façade area to rooftop area due to the need to accommodate mechanical, electrical, and plumbing (MEP) infrastructure. This makes façades a significantly underutilised surface, ideal for deploying BIPV.

Avenues for Growth of BIPV

Simultaneously, India is making remarkable progress in advancing green building standards and certifications. Ranked second globally by the U.S. Green Building Council (USGBC) for LEED certifications in 2022, India certified 323 projects spanning over 10.47 million square meters of space—more than double the number from the previous year. Additionally, India's homegrown Green Rating for Integrated Habitat Assessment (GRIHA) system further strengthens the nation's commitment to sustainable building standards with over 1700 GRIHA rated projects. With the updated Energy Conservation and Sustainable Building Code 2022, emphasising energy efficiency, RE integration, and sustainable building criteria, BIPV is a natural fit within the evolving regulatory framework, enabling compliance while promoting RE adoption in urban environments.

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[5] GIZ, CSTEP, et. al. 2024
[6] Database of swiss and EU solar buildings, www.solarchitecture.ch
[7] CPWD, Emerging Trends in Public Architecture, 2019
[8] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2022323#:~:text=This%20GVA%20growth%20has%20been,Q4%20of%20FY%202023%2D24.
[9] Indian Construction Industry, 2023

The PM Surya Ghar Muft Bijli Yojana, launched in 2024, is a transformative initiative aimed at promoting sustainable energy use and reducing electricity bills for households across India. It includes provisions for providing Central Financial Assistance (CFA) for residential households adopting solar technologies, including BIPV in its guidelines.

This synergy between regulatory advancements and BIPV deployment highlights its potential to align with India's sustainable development goals in the building sector.

***Global Leadership in BIPV: Europe's Integrated Approach*[10]**

Europe has established itself as a global leader in BIPV adoption, driven by strategic policies, innovative technology development, and a focus on integrating energy solutions into the built environment. Key initiatives such as the EU Solar Strategy and the Renovation Wave Strategy are designed to:

- Renovate 35 million buildings by 2030 with integrated RE systems like BIPV.
- Foster the development of an integrated EU value chain for BIPV, supporting domestic manufacturing and reducing dependency on imports.
- Support the training of professionals to bridge skill gaps in implementing advanced BIPV technologies.

Switzerland: A Pioneer in Solar Architecture

Switzerland has emerged as one of the most successful markets for BIPV, leveraging decades of innovation and government support. BIPV installations in Switzerland have experienced remarkable growth, with a compound annual growth rate (CAGR) of 41% from 2006 to 2023. By 2023, BIPV systems accounted for 6% of the country's total photovoltaic (PV) capacity. This growth is supported by Swiss incentives, which average 430 CHF per kilowatt-peak (kWp) for BIPV systems—higher than the subsidies provided for traditional PV installations. Additionally, the adoption of BIPV has been influenced by demonstration projects and initiatives that emphasise the urban integration of renewable energy. The market is currently dominated by prefabricated systems, rain screens, and walkable BIPV roofs. Furthermore, significant advancements in customisation options, including colour, texture, and design, have made BIPV aesthetically appealing for a variety of architectural applications.

Market Dynamics in Other European Countries

France leads the European BIPV market with 86 MWp installed in 2023, primarily driven by residential applications and supportive policies. The country has historically benefited from targeted support schemes that have contributed to widespread adoption. In Austria, rapid expansion in 2023 doubled its installations to reach 65 MWp of BIPV, fuelled by support schemes and a preference for distributed solar systems. Germany, a steady adopter of BIPV, has leveraged a robust distributed photovoltaic

[10] https://solarchitecture.ch/wp-content/uploads/2024/10/2024_report_BIPV_web-1.pdf

market, with BIPV installations accounting for 30-40 MWp of total capacity in 2023. Meanwhile, Italy and Spain are experiencing growth in their residential BIPV markets, showcasing unique applications designed for heritage and urban buildings.

Way forward for India[11]

Inspired by Europe's 40-year experience with BIPV, India can develop a strong BIPV ecosystem. Europe's commitment to integrating photovoltaics into buildings has created a thriving industry and a skilled workforce. Specialised players have driven innovation and technological advancement, supported by centres of excellence such as the Swiss BIPV Competence Centre at SUPSI (the University of Applied Science and Art of Southern Switzerland), founded in 2004. Such long-term investments have led to over 150 commercially available BIPV products, real solar architecture, and competitive industry blending construction and RE. International BIPV experiences, especially groups like IEA PVPS Task 15, showcase BIPV's potential in addressing architectural challenges and supporting urban development goals.

The way forward for India's BIPV ecosystem lies in fostering collaboration between the building and energy sectors. Driving conversations among architects, commercial space developers, policymakers, and industry leaders is critical to integrating BIPV into India's green building landscape. To this end, TERI and GRIHA organised preliminary stakeholder interactions and a panel discussion as part of the 16th GRIHA Summit, which provided a platform for aligning perspectives, identifying synergies, and establishing actionable roadmaps for large-scale BIPV adoption in India.

[11] https://energy.economictimes.indiatimes.com/news/renewable/solar-skyscrapers-transforming-indias-buildings-with-bipv-innovation/115963823

Insights from Preliminary Stakeholder Discussions

As a precursor to the panel discussion on the scaling up of BIPV applications in India, TERI conducted preliminary stakeholder discussions to assess the perception of the key architects and commercial space developers of the technology: figure 1 shows, the sample pool of questions discussed in the preliminary interactions.

Awareness and Perception

- How familiar are you with Building-Integrated Photovoltaics (BIPV)?
- What are your views on adopting BIPV for buildings?
- What benefits of BIPV are most appealing (e.g., energy savings, aesthetics, green building standards)?

Challenges and Concerns

- What concerns do you have about BIPV adoption (e.g., costs, design complexity, maintenance)?
- How do you perceive its scalability and financial feasibility in the Indian context?

Policy and Support

- How crucial is government policy support for BIPV adoption?
- What role should regulatory bodies play (e.g., subsidies, standardization, approvals)?

Design and Integration

- What types of BIPV solutions (e.g., façades, roofs, curtain walls) are suitable for your projects?
- What factors (e.g., compatibility, maintenance, performance) are essential when choosing a BIPV product?

Ecosystem for Collaboration

- Who are the key stakeholders for successful BIPV implementation?
- What qualities do you value in BIPV providers (e.g., warranties, on-site support, product reliability)?

Future Adoption

- Would you recommend BIPV to peers? Why or why not?
- How do you foresee BIPV shaping sustainable building practices in India?

Figure 1 Categorisation of Questionnaire for Preliminary Discussions

Summary of Discussions

Preliminary stakeholder discussions on BIPV highlighted a mix of cautious optimism and concerns in adopting the technology in the Indian context. While BIPV is perceived as a novel and innovative concept for sustainable architecture, stakeholders emphasised a significant awareness gap among architects, commercial space developers, and policymakers. Key benefits, such as aesthetic integration, energy efficiency, and compliance with green building standards, were acknowledged, but high upfront costs, design complexities, and maintenance requirements were seen as barriers. Recommendations focused on targeted outreach, government subsidies, and the exploration of innovative financing models to enhance adoption. Stakeholders also stressed the need for climate-zones specific pilot projects, modular solutions, and policy support, including incentives linked to green building certifications. Collaboration across disciplines and localised R&D were identified as critical for scaling BIPV in India.

Current Perception:

- Stakeholders view BIPV as an innovative but unfamiliar/novel concept in India, even for experienced professionals.
- For most developers, BIPV adoption feels aspirational or a unique selling proposition rather than a practical necessity.

Interest Areas:

- Curiosity to learn more about the **feasibility, applicability, and advantages** of BIPV for both new and retrofitted projects.
- Practical queries such as **various use cases** for BIPV, its potential to be **retrofitted** in the existing building stock, and how it can satiate building energy requirements in different ways.
- Financial queries regarding **ROI, its cost per square feet, payback**, and potential to **offset** existing energy costs of buildings.
- Technical queries like **comparison to conventional glass facades**, efficiency and durability of BIPV systems in the Indian climate
- Aesthetics queries like how it compares to conventional building materials in functionality and aesthetics, **extent of customisability**, and maintaining visual quality.

Stakeholder-Specific Requirements and Recommendations on Scaling Up BIPV in India

Among the three primary categories of stakeholders that we interacted with, we have bifurcated the key concerns highlighted by the architects, commercial space developers, and glass manufacturers/BIPV Specialists and their corresponding recommendations:

*Table 1 Stakeholder Perspective: **Architects***

Concerns/Requirements	Recommendations
Awareness Deficit: Architects have limited knowledge about BIPV functionality, applications, and long-term advantages. Hence, perceived hesitation to adopt BIPV without clear cost recovery pathways and quantifiable long-term benefits.	Organise targeted educational programs, workshops, and outreach campaigns tailored to architects and design professionals. Introduction of BIPV as a study material in undergraduate and graduate programmes
Design Integration/Aesthetic Compatibility: Challenges in aesthetically integrating BIPV into traditional construction materials and design paradigms. BIPV must integrate seamlessly with both traditional and modern architectural designs to gain widespread acceptance.	Availability of customisable PV panels with flexible colours, textures, and designs to harmonise with various architectural styles. Need for clarity on the performance of BIPV, especially on shaded or less optimal facades, to ensure effective energy generation.
Cost Concerns: High upfront costs and unclear return on investment deter adoption.	Provide cost-benefit calculators and tools that showcase lifecycle energy savings, payback periods, and compliance benefits (e.g., green building certifications).
Material Compatibility and Meteorological Conditions Considerations: Limited availability of BIPV materials compatible with standard construction processes. Concerns over the accumulation of dust on facades, especially in urban areas, which may impact efficiency and require specialised cleaning solutions.	Introduce pre-integrated systems that align with conventional building materials and construction workflows. Manufacturers must provide third-party maintenance/ AMCs to ensure ease in installation and maintenance.
End-User Impact: Lack of clear articulation of BIPV benefits for end-users (occupants). Hence, perceived difficulty in convincing clients and occupants of the immediate benefits, particularly when the cost of adoption is high.	Create marketing materials and case studies that communicate how BIPV enhances occupant experience through energy savings, thermal comfort, and aesthetic value.

*Table 2 Stakeholder Perspective: **Commercial Space Developers***

Concerns/Requirements	Recommendations
High Installation Costs: Upfront costs of BIPV systems are significantly higher than traditional glass facades and aluminium composite panels: CAPEX and OPEX considerations; Long-term ROI, with an industry-estimated breakeven period of seven years.	Develop/Explore innovative financing models to spread the financial burden over time. Need further clarity on data from existing successful case studies to make a viability case for BIPV.
Energy Balance Trade-offs: BIPV installations (e.g., glass facades) might lead to increased internal lighting energy needs due to reduced transparency.	Conduct holistic energy analyses to balance HVAC savings with increased lighting energy demands.
Aesthetic Prioritisation: Visual appeal is critical in high-end commercial spaces, making seamless integration of BIPV into the building's design a top priority.	Design visually appealing and functionally efficient BIPV products, particularly for facade and shading applications.
Retrofitting Challenges: Limited feasibility of integrating BIPV into existing structures due to design orientations, utilities, and lifecycle constraints.	Focus on pre-integrated BIPV systems for new constructions and explore modular retrofitting solutions for existing buildings.
Policy and Subsidy Gaps: Limited government incentives and unclear processes to avail benefits from existing scheme.	Advocate for simplified subsidy schemes, tax exemptions, and regulatory incentives specific to commercial BIPV applications. Desire for cost-based incentives, such as FAR (Floor Area Ratio) bonuses, tax incentives, and green building certifications to offset initial investment and improve ROI.
Stakeholder Involvement: Lack of early involvement of architects and design consultants in planning BIPV projects.	Mandate collaboration among architects, developers, and consultants during the conceptualisation phase to ensure practical integration and design harmony.
Skilled Workforce Availability: Challenge of sourcing a skilled workforce to manage BIPV systems throughout their lifecycle, from installation to long-term maintenance.	Manufacturers must provide end-to-end solutions, including installation, training and capacity building, maintenance, and warranties, to ensure the reliability and longevity of BIPV systems.

*Table 3 Stakeholder Perspective: **Glass Manufacturers/ BIPV Specialists***

Concerns/Requirements	Recommendations
High Costs Compared to Conventional Materials: BIPV systems cost significantly more than standard options (e.g., glass facades priced at ₹12,000–₹14,000 per square meter versus BIPV's ₹19,000–₹22,000).	Launch pilot projects and demonstration sites to validate economic feasibility and ROI in different climatic zones and use cases.
Scepticism About Energy Output: Stakeholders question the reliability and energy generation potential of BIPV systems, especially in vertical applications.	Share case studies of successful installations and performance data to build confidence in BIPV energy generation capabilities.
Limited Manufacturer Expertise: Few manufacturers specialise in both photovoltaics and construction, leading to quality concerns.	Foster cross-disciplinary partnerships between solar technology firms and construction material companies to improve product quality and service offerings. Leverage India's manufacturing potential for developing multi-functional modules.
Customisation and Scalability: Lack of /limited modular, scalable solutions that can be adapted to diverse building types and climates.	Invest in R&D for modular designs that enhance scalability and enable easier integration into existing construction processes.
Policy Integration: BIPV is not fully incentivised in green building certifications like GRIHA and LEED.	Advocate for additional credits in green building standards specifically for BIPV adoption to encourage developers to prioritise its use.
Knowledge Dissemination: Developers and architects lack access to detailed technical guidance and training for implementing BIPV systems effectively.	Collaborate with academic institutions and industry associations to provide specialised training, research programs, and best-practice guidelines.

Insights from the Workshop/ Stakeholders’ Insights from Roundtable

The BIPV workshop, organised as a side-event at the 16th GRIHA Summit, brought together key stakeholders—architects, commercial space developers, international BIPV players, representatives from government agencies, bilaterial organisations, think tanks, academia, and RE industry players—to deliberate further on the barriers and opportunities for scaling up BIPV applications in the country.

Key Themes Discussed and Highlights

1. ***Role of BIPV in Energy Transition and Sustainable Building Strategies:*** BIPV was presented as a solution to meet India’s ambitious target of 500 GW non-fossil energy by 2030, complementing ground-mounted and rooftop solar installations. Its ability to turn underutilised building surfaces (rooftops, façades, and windows) into energy generators was highlighted. The discussions emphasised BIPV’s potential to decentralise power generation, reducing grid inefficiencies by producing electricity close to demand centres. Integration with urban infrastructure to promote energy resilience in cities was discussed.

2. ***Policy, Regulations, and Market Readiness:*** The absence of BIPV in government standards, like CPWD schedules, was identified as a significant barrier. The need for inclusion in public sector

projects and housing schemes like PMAY was stressed to catalyse adoption. Recommendations included providing subsidies, tax incentives, and low-interest loans to offset high upfront costs. Emphasis on awareness campaigns to create demand among developers, architects, and end-users. There were also discussions about fostering public-private partnerships to bridge gaps in technology and infrastructure.

3. ***Architectural Integration and Aesthetic Design:*** BIPV's adaptability to various architectural styles, including modern, heritage, and traditional, was discussed. Customisable options such as colour-matching, patterns, and textures were highlighted as key to aesthetic integration. Addressing shading, ventilation, and glare issues in dense urban environments was a recurring theme. Integration with existing materials and retrofits for older buildings without compromising aesthetics or structural integrity was explored. Concerns were raised about integrating BIPV into heritage buildings while preserving architectural character and compliance with conservation norms.
4. ***Technological Innovations:*** Technologies like vacuum coating and PVD (Physical Vapor Deposition) that allow modules to mimic traditional materials were discussed. Innovations in translucent and colour-stable coatings for improved aesthetics and efficiency were highlighted. BIPV as a complement to passive energy-efficient elements, such as low-emissivity glazing, was explored. The role of BIPV in reducing heating, cooling, and lighting demands in buildings was also emphasised. Discussions ensued on regional standardisation of BIPV modules to lower costs while catering to diverse Indian climatic and architectural needs.

5. ***Economic and Employment Opportunities**:* Scaling BIPV adoption to reduce costs through economies of scale and streamlined production was highlighted. Advocacy for the mass production of standardised components to enable affordable solutions. BIPV's potential to create skilled jobs in manufacturing, installation, and maintenance was recognised. Importance of skilling and reskilling programs for architects, engineers, and construction workers to support the transition.
6. ***Barriers to Adoption**:* High upfront investments required for BIPV systems were discussed as a primary deterrent, particularly for small developers and residential sectors. Limited understanding among architects, urban planners, and developers about BIPV's benefits and applications. Lack of accessible tools for architects to calculate cost-benefit ratios and integrate BIPV seamlessly into designs. Concerns about the efficiency and durability of BIPV systems in India's diverse climatic conditions. Challenges in integrating BIPV with unconventional or atypical Indian building materials.

7. ***International Perspective:*** The workshop saw international representation from organisations such as SUPSI, Von Ardenne, Arconsol and Sunage. Applications and Global Case Studies on BIPV were disseminated, including examples of residential complexes with energy-positive buildings, commercial façades with advanced designs, and heritage buildings retrofitted with BIPV. Innovative examples of integrating BIPV in parking lots and industrial spaces demonstrated its versatility. Custom designs tailored for specific architectural requirements, from colour-

matching façades to invisible integration were highlighted. Details on the use of PVD (Physical Vapor Deposition) coatings to ensure visual harmony in sensitive urban and heritage settings were discussed. The standardisation of BIPV components to bring down production costs while maintaining design flexibility for architects was advocated and the creation of regional standards to cater to India's diverse climatic zones and architectural styles was discussed.

Key Recommendations

Category	Government Actions	Industry Actions
Policy and Regulatory Frameworks	• Introduce tax incentives, subsidies, and FAR (Floor Area Ratio) bonuses for BIPV installations. • Integrate BIPV into green building codes and urban development guidelines as mandatory requirements.	• Collaborate with policymakers to advocate for favourable regulations and provide feedback on their implementation. • Develop products that align with green building codes and integrate into existing architectural designs.
Capacity Building and Awareness	• Organise training programs for policymakers, architects, and developers on BIPV benefits and feasibility. • Fund and promote pilot projects across various climatic zones to showcase the potential of BIPV technology. • Run public awareness campaigns to highlight the benefits of BIPV for energy savings and sustainability.	• Host workshops and contribute to training sessions on integrating BIPV into building designs. • Participate in pilot projects to demonstrate innovative BIPV solutions and ensure quality implementation. • Leverage marketing platforms to share case studies, success stories, and practical applications of BIPV.
Research and Development	• Fund collaborative research between academia and industry for designing localised BIPV solutions tailored to India's climate and urban conditions. • Support studies on dust accumulation, shading, and thermal impacts specific to Indian environments.	• Invest in R&D for modular, scalable, and aesthetically appealing BIPV products that cater to diverse building needs and climatic conditions. • Conduct and share performance validation studies to refine and validate BIPV product designs.
Financial and Business Models	• Develop innovative financing mechanisms, such as low-interest loans and public-private partnerships, to reduce upfront costs.	• Develop accessible calculators and software tools for real-time cost and benefit analysis of BIPV systems. Leverage participation of IIA, GRIHA, and TERI for the same.

Category	Government Actions	Industry Actions
Industry Collaboration and Ecosystem Development	• Facilitate the establishment of local manufacturing facilities to strengthen the supply chain of BIPV products. • Standardise testing protocols and performance benchmarks for BIPV products to ensure quality and safety.	• Invest in local production capabilities to lower costs and improve access to customisable BIPV systems. • Provide integrated services, including end-to-end installation solutions, and maintenance to enhance adoption rates.
Integration into Existing Infrastructure	• Develop policies and guidelines for retrofitting BIPV systems in older buildings. • Include BIPV incentives in programmes like PMAY and other public sector housing initiatives.	• Create modular retrofitting solutions that are compatible with existing structures and enhance aesthetic and functional appeal. • Collaborate on retrofitting projects to demonstrate feasibility and highlight benefits in different building typologies.

Conclusion

Scaling up BIPV presents a transformative opportunity to redefine India’s approach to sustainable urban development. By fostering collaboration with international experts, leveraging localised solutions through research and innovation, and engaging the private sector in pilot initiatives, India can establish a robust ecosystem for BIPV adoption. Comprehensive educational programmes and tools will be pivotal in equipping stakeholders with the necessary skills and knowledge to integrate BIPV effectively into the built environment. Panel discussions and stakeholder engagements, such as those conducted for this white paper, play a crucial role in facilitating large-scale adoption by bringing together diverse perspectives from policymakers, architects, developers, and manufacturers. These dialogues help identify challenges, bridge knowledge gaps, and co-create actionable roadmaps tailored to the unique needs of the Indian context. They ensure that the solutions proposed are inclusive, feasible, and grounded in practical insights from the ground. As a cornerstone of India's green building movement, BIPV has the potential to align with national sustainability goals, reduce carbon emissions, and contribute to energy self-reliance. Moreover, its integration into urban infrastructure can transform cities into energy-efficient hubs, enhancing both liveability and aesthetic appeal. The journey towards widespread BIPV adoption requires a synergistic effort across government, industry, and academia to unlock its full potential.

ANNEXURE

Stakeholders consulted for preliminary discussions:

- **Mr. Anil Kumar Singh-** Associate Vice President, MEP, Advance India Projects Limited (AIPL)
- **Mr. Parthasarathi Chakrabarti-** Vice President- Designs, AIPL
- **Mr. Zohaib Siddique-** Senior General Manager - Architecture & Design, Whiteland Corporation
- **Ms. Archana Khanna-** Founding Partner, FIRST PRINCIPLE & Convener, Sustainability Committee, Indian Institute of Architects (IIA), Northern Chapter
- **Mr. Aditya Dave-** Founder and CEO, Cibos Techno Solutions Pvt. Ltd.
- **Mr. Gautam Dey-** President- Project Commissioning, Asset Management, Clubs, Interior Fitout, Event Management, M3M India Pvt. Ltd.
- **Mr. Karthik Pillai**- Manager, Façade Engineering, AGC Asia Pacific Pte Ltd.

BACKGROUND NOTE AND AGENDA

Side Event during the 16th GRIHA Summit
Innovative Strategies for Sustainable Construction:
Scaling up Building Integrated Photovoltaics (BIPV) Applications in India

Thursday, 5 December 2024 | Time: 0930 – 1330 hrs (IST) | Jacaranda Hall - 2
India Habitat Centre, Lodhi Road, New Delhi, India

On its journey to achieve net zero by 2070, India is making significant progress in deploying clean technologies like solar PV to meet growing energy demands. The building and construction sector, which accounted for approximately 17% of India's total greenhouse gas (GHG) emissions in 2019[12], must undergo substantial decarbonisation to support the country's energy transition. The production, transport, and processing of traditional building materials have historically led to high embodied energy consumption and a sizeable carbon footprint. Now, as the construction industry pivots towards sustainability, **BIPV has emerged as a promising solution, integrating solar PV directly into building structures**.

In response to this, the New and Innovative Solar Applications (NISA) programme was launched jointly by GIZ and the Ministry of New and Renewable Energy (MNRE) to unlock the untapped potential of solar technologies like BIPV. Under this initiative, **India's BIPV potential was estimated at an impressive 309 GW[13].** However, several barriers continue to hinder progress, including high upfront costs, higher tariffs due to limited product availability, challenges in cleaning and maintenance, a lack of standardisation, and other technical issues related to implementation.

The 16th GRIHA Summit aims to explore vital strategies for achieving sustainability by emphasising the essential aspects of policy advocacy, stakeholder action, energy transition and promoting smart & resilient infrastructure development. **This session**—a side event at the GRIHA summit— is being organised by TERI and GRIHA Council, under the Development Partnership with the Private Sector (dPP) project by GIZ India and Ornate Solar, aimed at promoting and scaling up the adoption of BIPV in India over the next three years. The session will **examine the challenges and opportunities associated with BIPV adoption**, focusing on feasibility, efficiency, capacity building, and the sustainability of current PV materials. While BIPV holds the promise of reducing reliance on conventional energy by generating power at the building level, **we will address key concerns around balancing aesthetics with efficiency, the lifecycle impacts of BIPV materials, and the economic viability of large-scale applications.**

Furthermore, the session will explore recent research and technological advancements in BIPV, including innovations in transparent PV modules, lightweight designs, and energy-efficient coatings. By

[12] https://www.wri.org/insights/india-just-transition-low-carbon-construction
[13] (GIZ, CSTEP, et. al., 2023)

reviewing successful case studies, participants will gain valuable insights into material performance, design integration, and the sustainability benefits of BIPV. This forward-looking approach aims to support a resilient transition in construction practices, paving the way for **net-zero energy buildings**.

Provisional Agenda

Time	Activity
0930 – 1000 hrs	**Registration**
1000 – 1045 hrs	**Welcome Address** • ***Mr. Girish Sethi***, *Senior Fellow & Senior Director-Energy Programme, The Energy and Resources Institute (TERI)*
	Special Remarks • ***Mr. Abhinav Jain***, *Senior Energy Advisor, GIZ India* • ***Ms. Archana Khanna,*** *Founding Partner, FIRST PRINCIPLE & Convener, Sustainability Committee, Indian Institute of Architects (IIA), Northern Chapter* **Keynote Address** • ***Dr. Mohammad Rihan***, *Director General, National Institute of Solar Energy (NISE)* • ***Ms. Varsha Punhani,*** *Head HSMI, Housing and Urban Development Corporation (HUDCO)*
1045 – 1130 hrs	**Technical Presentation** • ***Dr. Dieter Moor***, *CEO & Founder, Arconsol* • ***Mr. Dirk Bräunlich***, *Director of Sales and Business Development-Asia, Von Ardenne* • ***Mr. Gazmend Luzi,*** *Chief Executive Officer (CEO), Sunage* • ***Dr. Pierluigi Bonomo,*** *Senior Researcher, University of Applied Sciences and Arts of Southern Switzerland (SUPSI)**
1130 – 1150 hrs	**Networking Tea/ Coffee Break**

*Online

Time	Activity
Panel Discussion on "Scaling up BIPV Applications in India"	
1150 – 1200 hrs	**Context Setting Presentation** ***Ms. Hemakshi Malik****, Electricity & Renewables Division (ERD), TERI*
1200 – 1300 hrs	**Session Moderator:** ***Mr. Daniel Lipschits****, Strategy and Development Sun Appeal India & Esylys LLP StrategyDirector* **Panellists:** • ***Mr. Gautam Dey****, President- Project Commissioning, Asset Management, Clubs, Interior Fitout, Event Management, M3M India Pvt. Ltd.* • ***Mr. Zohaib Siddique****, Senior General Manager - Architecture & Design, Whiteland Corporation* • ***Mr. Hans-Peter Merklein****, Entrepreneur, Unltd Solar* • ***Mr. C K Varma,*** *Former Special Director General, Central Public Works Department (CPWD), Government of India* • ***Mr. Amit Sharma****, Principal Architect, Axiom India* • ***Mr. Akash Deep****, Deputy General Manager and Treasurer, GRIHA Council* • ***Mr. Anurag Bajpai****, Director, GreenTree Global*
1300 – 1325 hrs	**Q&A**
1325 – 1330 hrs	**Concluding Remarks** ***Mr. Sanjay Seth****, Vice President and Chief Executive Officer (CEO), GRIHA Council & Senior Director, Sustainable Habitat Division, TERI*
1330 hrs onwards	**Networking Lunch**

List of Participants

Sr. No.	Name	Organisation	Designation
1	Mr. Girish Sethi	The Energy and Resources Institute (TERI)	Senior Fellow & Senior Director-Energy Programme
2	Mr. Abhinav Jain	GIZ India	Senior Energy Advisor
3	Ms. Archana Khanna	FIRST PRINCIPLE & Convener, Sustainability Committee, Indian Institute of Architects (IIA), Northern Chapter	Founding Partner
4	Dr. Mohammad Rihan	National Institute of Solar Energy (NISE)	Director General
5	Ms. Varsha Punhani	Housing and Urban Development Corporation (HUDCO)	Head HSMI
6	Dr. Dieter Moor	Arconsol	CEO & Founder
7	Mr. Dirk Bräunlich	Von Ardenne	Director of Sales and Business Development-Asia
8	Mr. Gazmend Luzi	Sunage	Chief Executive Officer (CEO)
9	Dr. Pierluigi Bonomo	University of Applied Sciences and Arts of Southern Switzerland (SUPSI) - ONLINE	Senior Researcher
10	Mr. Daniel Lipschits	Sun Appeal India	Strategy and Development
11	Mr. Gautam Dey	Asset Management, Clubs, Interior Fitout, Event Management, M3M India Pvt. Ltd.	President- Project Commissioning
12	Mr. Zohaib Siddique	Whiteland Corporation	Senior General Manager - Architecture & Design

13	Mr. Hans-Peter Merklein	Unltd Solar	Entrepreneur
14	Mr. C K Varma	Central Public Works Department (CPWD), Government of India	Former Special Director General
15	Mr. Akash Deep	GRIHA Council	Deputy General Manager and Treasurer
16	Mr. Anurag Bajpai	GreenTree Global	Director
17	Mr. Sanjay Seth	GRIHA Council & Senior Director, Sustainable Habitat Division, TERI	Vice President and Chief Executive Officer (CEO)
18	Ms. Franziska Hinsche	GIZ India	Project Manager
19	Mr. Matthias Ramthun	GIZ India	Jr. Project Manager
20	Mr. Valentin Jascha Kossack	GIZ India	Project Manager
21	Mr. Anurag Verma	GIZ India	Energy Advisor
22	Ms. Nupur Sharma	GIZ India	Energy Advisor
23	Mr. Awatans Tripathi	GIZ India	Jr. Energy Advisor
24	Mr. Anand Saboo	Design Sahyogway	Principal Architect
25	Mr. Debarghya Kumar	Ornate Solar	Design Lead
26	Mr. Barun Iswarary	Ornate Solar	Industrial designer
27	Mr. Aayush Sharma	Ornate Solar	Sr. Design Engineer

28	Mr. Aditya Goel	OrnateSolar	CEO
29	Mr. Saurabh Tanaji	Von Ardenne	
30	Dr. Debajit Palit	NTPC School of Business	Professor
31	Dr. Khushal	SPA	Professor
32	Mr. Deepak Tewari	WRI	Research Fellow
33	Mr. Shubh Goel	Self Employed	Architect
34	Dr. Adersh Asok	CSIR-NIIST	Scientist
35	Mr. Rahul Meena	NITI Aayog	Consultant II
36	Ms. Arshi Chadha	Trillectric	Startup
37	Prof. Shailja Sikarwan	DCRUST, Murthal	Professor
38	Ms. Disha Khosla	ISGF	Senior Manager
39	Mr. Shantanu Roy	CSTEP	Policy Specialist
40	Mr. Saurabh Madan	Penumbra	Architect
41	Mr. Karthik Parthasarathy	PXE	Consultant
42	Mr. N. K. Chaudhary	Supreme Court	Advocate
43	Mr. Alekhya Datta	The Energy and Resources Institute (TERI)	Associate Director

44	Dr. Arunendra K Tiwari	The Energy and Resources Institute (TERI)	Associate Fellow
45	Ms. Hemakshi Malik	The Energy and Resources Institute (TERI)	Research Associate
46	Mr. Chaitanya Baruah	The Energy and Resources Institute (TERI)	Project Associate
47	Ms. Apoorva Singh	The Energy and Resources Institute (TERI)	Research Associate
48	Mr. Aniket Tiwari	The Energy and Resources Institute (TERI)	Research Associate
49	Mr. Mahavir Singh	The Energy and Resources Institute (TERI)	Research Associate
50	Mr. Robin Mazumdar	The Energy and Resources Institute (TERI)	Consultant
51	Mr. D Saji	The Energy and Resources Institute (TERI)	Manager
52	Ms. Pooja Gulati	The Energy and Resources Institute (TERI)	Executive Assistant
53	Mr. Madhur Gupta	Saint Gobain	National Manager - Luxe Segment