

Transparent Solar Windows: Powering Sustainable Buildings for Future India

AIM:

To develop and promote transparent solar window technology that generates clean electricity while allowing natural light, thereby enabling energy-efficient and sustainable infrastructure in both urban and rural India, aligned with the vision of a low-carbon Future India.

OBJECTIVES:

- **To design and implement transparent solar window systems** that convert non-visible sunlight (UV and IR) into electricity while allowing visible light to pass through.
- **To reduce dependency on conventional energy sources** by integrating solar power directly into building structures without compromising aesthetics or natural lighting.
- **To support India's low-carbon and net-zero goals** by promoting energy-efficient infrastructure in both urban and rural settings.
- **To make the technology MSME-friendly** by enabling local production, installation, and maintenance of solar window units under the "Make in India" initiative.
- **To improve sustainability in public buildings** such as schools, healthcare centers, and community halls, especially in power-deficit or remote regions.
- **To demonstrate a scalable clean energy solution** suitable for smart cities, green buildings, and eco-friendly housing projects across India.

INNOVATION DESCRIPTION:

- ❖ The proposed innovation lies in the integration of transparent photovoltaic (PV) technology into standard building windows, enabling them to generate electricity from sunlight while maintaining their primary function of allowing natural light.
- ❖ Unlike traditional solar panels that are bulky and opaque, transparent solar windows absorb only the non-visible parts of sunlight (ultraviolet and infrared), converting them into usable electrical energy, while visible light passes through—making them ideal for aesthetic, space-saving, and energy-efficient applications.
- ❖ This innovation supports India's sustainability and green building goals, especially in space-constrained urban areas and energy-deficient rural zones. The technology can be tailored for homes, schools, offices, hospitals, and smart village infrastructure, with strong potential for local MSME involvement in manufacturing and deployment under the Make in India and Atmanirbhar Bharat missions.

POTENTIAL AREAS OF APPLICATION:

- ✓ **Urban Residential and Commercial Buildings** – Integration into windows of apartments, office towers, and shopping complexes to reduce grid electricity usage and promote green construction.
- ✓ **Educational Institutions** – Use in schools, colleges, and university buildings to provide natural lighting while generating clean energy for lighting and fans.
- ✓ **Healthcare Facilities** – Installation in hospitals and primary health centers to support energy efficiency and backup power during outages.
- ✓ **Government and Smart Village Infrastructure** – Application in Panchayat buildings, community centers, and rural electrification programs, especially in regions with frequent power cuts.
- ✓ **Transport Terminals** – Use in airports, railway stations, and bus depots to power lighting and signage without taking up roof space.
- ✓ **Eco-Tourism and Hospitality Industry** – Ideal for sustainable resorts, lodges, and hotels aiming for energy independence and eco-certification.
- ✓ **Industrial Campuses** – For day lighting and energy generation in factory windows, conference rooms, and admin blocks.

TECHNOLOGY:

- Utilizes building-integrated photovoltaic (BIPV) technology within transparent glass panels.
- Incorporates transparent photovoltaic materials such as organic photovoltaic (OPV) cells or quantum dots.
- Absorbs non-visible solar spectrum (ultraviolet and infrared light) while allowing visible light to pass through.
- Converts solar energy into direct current (DC) electricity using the photoelectric effect.
- Conductive layers embedded in the glass transfer electricity to the edges for connection.
- Electricity can be directed to an inverter, battery storage, or directly into the building's electrical system.
- Compatible with standard window frames for easy integration in both new buildings and retrofits.
- Can function in both grid-connected and off-grid environments.
- Designed to provide dual functionality: natural daylight and renewable power generation.

STRATEGIES:

- Focus on building-integrated photovoltaics to integrate solar technology directly into window structures.
- Use transparent photovoltaic materials that absorb ultraviolet and infrared light while allowing visible light to pass through.
- Design the system to be modular and compatible with standard window dimensions for easy adoption.
- Ensure the windows serve a dual purpose of daylighting and power generation without affecting room aesthetics.
- Make the system suitable for both new buildings and retrofitting existing infrastructure.
- Target applications in urban and rural sectors, especially in areas with limited space for traditional solar panels.
- Collaborate with MSMEs for local manufacturing, assembly, and installation under the Make in India initiative.
- Plan scalability through pilot installations, feedback, and continuous improvements.
- Align with national sustainability goals to attract policy support and green funding.

KEY OUTCOMES:

1. **Reduces electricity consumption by up to 30–50%** during daytime by generating clean energy from windows.
2. **Generates 30–50 watts per square meter**, contributing to 10–15% of a building's total energy needs.
3. **Improves energy efficiency** and reduces **CO₂ emissions by 20–25%** per building installation.
4. **Maintains 60–80% transparency**, allowing natural daylight while producing electricity.
5. **Lowers cooling load by 10–12%** by blocking infrared heat from sunlight.
6. **Supports India's green building and net-zero goals**, with strong potential for MSME-led local manufacturing.

Conclusion:

Transparent Solar Windows offer a smart and sustainable way to produce electricity without blocking natural light. They can be used in homes, schools, offices, and hospitals to save energy and reduce electricity bills. This solution supports clean energy goals and can be made and installed locally by MSMEs. It is suitable for both cities and villages and helps build a greener future for India.