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Swiss Agency for Development and Cooperation SDC

IIEC
International Institute for Energy Conservation

eds BASE

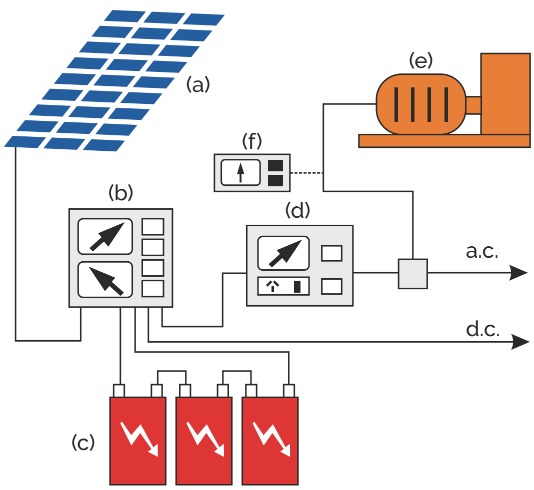
Building Integrated PV Solutions

Source: Indiamart

A Building Integrated Photovoltaics (BIPV) system consists of integrating photovoltaics modules into the building envelope, such as the roof or the facade. By simultaneously serving as building envelope material and power generator, BIPV systems can provide savings in materials and electricity costs, reduce use of fossil fuels and emission of ozone depleting gases, and add architectural interest to the building.

While the majority of BIPV systems are interfaced with the available utility grid, BIPV may also be used in stand-alone, off-grid systems. One of the benefits of grid-tied BIPV systems is that, with a cooperative utility policy, the storage system is essentially free. It is also 100% efficient and unlimited in capacity. Both the building owner and the utility benefit with grid-tied BIPV. The on-site production of solar electricity is typically greatest at or near the time of a building's and the utility's peak loads. The solar contribution reduces energy costs for the building owner while the exported solar electricity helps support the utility grid during the time of its greatest demand.

Components of BIPV



- (a) The PV modules (which might be thin-film or crystalline, transparent, semi-transparent, or opaque)
- (b) A charge controller, to regulate the power into and out of the battery storage bank (in stand-alone systems)
- (c) A power storage system, generally comprised of the utility grid in utility-interactive systems or, a number of batteries in stand-alone systems
- (d) Power conversion equipment including an inverter to convert the PV modules' DC output to AC compatible with the utility grid
- (e) Backup power supplies such as diesel generators (optional-typically employed in stand-alone systems)
- (f) Appropriate support and mounting hardware, wiring, and safety disconnects

Classifications of the BIPV Systems

BIPV systems can be roughly **classified according to the energy supply,** the storage modes, the integrating modes, and the module types. According to the power supply and storage modes, there are two types: the grid-connected type and the stand-alone type. The former is usually connected to a utility grid that serves as a storage component in the BIPV system and ensures the system's stability and reliability. The latter type, on the other hand, employs batteries for surplus power storage. The battery also helps to ensure the stable power supply for the fluctuating power generation. In stand-alone BIPV systems, a supplementary generator is usually necessary for power supply in extreme weather conditions.

According to the integration pattern, BIPV systems could be roughly classified as building-integrated systems and building-applied PV systems. The former is suitable for new buildings by substituting conventional building materials with PV modules, while the latter is easily applied to existing buildings by adding PV modules to some parts of their envelopes.

According to the module shape, BIPV systems can be categorized as rigid-module-based BIPV systems and flexible-module-based BIPV systems. The former is built by rigid BIPV modules, while the latter is built by flexible BIPV modules.

According to their optical properties, BIPV systems can be classified as opaque systems and semi-transparent systems. The former often refers to BIPV systems implemented on opaque building envelopes (roofs or walls), where PV modules are added onto. No sunlight is allowed to pass through the system into the indoor environment. Semi-transparent BIPV systems can be built in see-through building envelope components, such as façades, windows, atriums, skylights, etc.

BIPV Application and Potential End Use

Output energy	Application	Suitable Building type	Specific requirement
Electricity	Offset Building electricity consumption & Export to Grid	High Rise Buildings	Vertical façade exposed to sun without obstructions

Source: Zigzag solar

Applications of BIPV Technologies

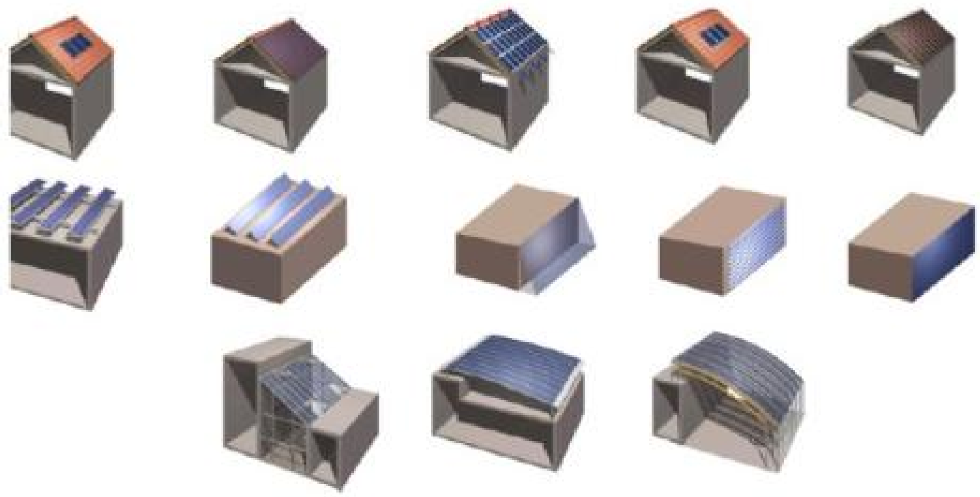
BIPV Technologies

- Conventional or BAPV systems (roofs, canopies)
- Wall integrated semi-transparent glazings
- Clear, uncoloured solar windows and skylights
- Traditional (Si, a-Si, CdTe), or new PV materials (polymers, perovskites,...)
- Luminescent concentrators, or patterned, cell module type

Manufacturer of Building Integrated PV Solutions in India

- Novergy Solar
- U-Solar
- Zig Zag Solar

Typical building applications of BIPV



Source: https://firstgreenconsulting.wordpress.com/2013/07/10/bipv-module-mounting-techniques/

Source: Saur energy

Case Study

In 2019, U-Solar Clean Energy Solutions Pvt. Ltd. installed India's largest building integrated vertical solar PV system at a data center in Mumbai. The system, with a capacity of about 1 MW, has been installed by integrating solar panels on all four walls of the facility, covering over 5000 square feet of facade area. It called for the use of custom designed aluminum rails as the module mounting structure. Frameless panels were used on the facade. The panels were connected as they were placed on the structure, and electrical work and construction took place simultaneously for timely delivery. Since the building was already constructed, this was a constraint on the solar energy that could be harnessed. To partially address this issue, power optimizers have been used on each panel. Power optimizers increase energy output from PV systems by constantly tracking the maximum power point (MPPT) of each module individually. They can also monitor the performance of each module. In terms of environmental benefits, U-Solar estimates the solar power system will help provide a CO_2 emissions reduction equivalent to almost 7000 trees per year.

In recent years, BIPV has been developing rapidly due to advances in technology, the cost reduction in PV materials, and an increase in governments' incentive policies for renewable energy technologies.

The biggest advantage of BIPV is that the integration of PV modules brings a high on-site electricity production potential for modern buildings. The electricity generation potential of BIPV in buildings, cities, and countries confirms that promoting BIPV applications would be a great help for the future production and supply of regional electricity demands. BIPV also brings about some by-produced advantages related to architectural aesthetics and energy efficiency aspects compared to conventional buildings, i.e., indoor thermal load reduction and day lighting provision.

Performance of BIPV Systems

In the case of vertical BIPV systems, a reduced output should be expected as all the panels cannot be placed in the optimal direction from a power generation point of view.

The table is on right side shows the output for a small 1 kW system.

Clearly, the power output is reduced to almost half as a result of the orientation. However, BIPV substantially increases the quantum of local energy generation, and a decision on the viability should be done after evaluating the system's return on investment (ROI).

Solar panel's tilt relative to the horizontal	Direction of the solar panel	Annual output for a 1kW DC solar system (kWh/year. in Delhi)	Output relative to highest generation (%)
Vertical	North	391	27
Vertical	East	630	44
Vertical	South	871	60
Vertical	West	795	55
Average of all four Vertical systems		672	47
Horizontal	-	1312	91
Latitude	South	1442	100

Source: U-Solar