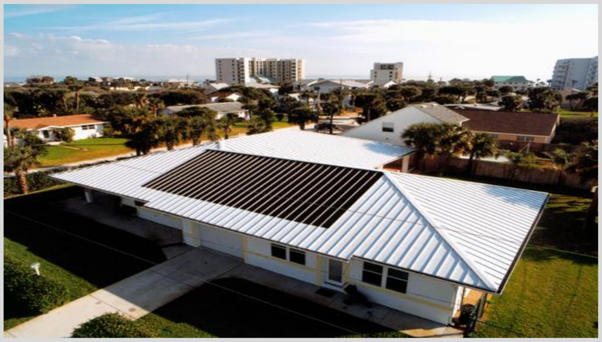
Building-Integrated Photovoltaics

Overview

Building-integrated photovoltaics (BIPV) are dual-purpose: they serve as both the outer layer of a structure and generate electricity for use or export to the grid. BIPV systems can provide savings in materials and electricity costs, reduce pollution, and add to the architectural appeal of a building. Though they can be added to a structure as a retrofit, the greatest value for BIPV systems is realized by including them in the initial building design. By substituting PV for standard materials during the initial construction, builders can reduce the incremental cost of PV systems and eliminate costs and design issues for separate mounting systems. *Building-integrated PV* systems are planned during the architectural design stage and are added during initial construction. *Building-added PV* (BAPV) is planned and built during a retrofit. Both BIPV and BAPV lack the racks and mounting equipment of traditional PV systems.

Most designers of integrated solar system will consider the array of solar technologies and their possible uses compared to the specific needs of building occupants. For example, semi-transparent thin-film PV can allow for natural day lighting and solar thermal systems can capture heat energy to generate usable hot water or provide space heating and cooling capacity.



This zero-energy home in Florida gets 100% of its power from a 3.3 kW solar system. Hot water is provided by a solar thermal system with a natural gas backup. (Above: Photo—Steven Spencer)

Solar shingles, produced by Dow Chemical in partnership with Global Solar Energy and the US Department of Energy. These shingles eliminate on-roof wiring, reduce roof penetrations and can be handled and nailed just like asphalt shingles. (Below: Photo—Dow Chemical)

BIPV Applications

- *Façade* **–** PV can be integrated into the sides of buildings, replacing traditional glass windows with semi-transparent thin-film or crystalline solar panels. These surfaces have less access to direct sunlight than rooftop systems, but typically offer a larger available area. In retrofit applications, PV panels can also be used to camouflage unattractive or degraded building exteriors.

- *Rooftops* **–** in these applications, PV material replaces roofing material or, in some cases, the roof itself. Some companies offer an integrated, single-piece solar rooftop made with laminated glass; others offer solar “shingles” which can be mounted in place of regular roof shingles.

- *Glazing* – ultra-thin solar cells may be used to create semi-transparent surfaces, which allow daylight to penetrate while simultaneously generating electricity. These are often used to create PV skylights or greenhouses.

Design Considerations

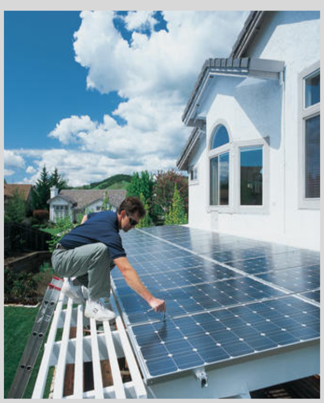
A critical part of maximizing the value of a BIPV system is planning for both environmental and structural factors, both of which influence the economics, aesthetics and overall functionality of any solar system.

Environmental Factors

- *Insolation* – this refers to the average amount of solar radiation received, usually calculated in $kWh/m^2/day$. It is the most common way to describe the amount of solar resources in a particular area.
- *Climate and weather conditions* – high ambient temperatures can decrease the output of solar systems, and clouds and rainfall patterns can affect system output and maintenance requirements. High levels of air pollution can require regular cleaning to limit efficiency losses.
- *Shading* – trees, nearby buildings and other structures can block the sun, reducing PV system output.
- *Latitude* – distance from the equator affects the optimal tilt angle for solar panels to receive solar radiation.

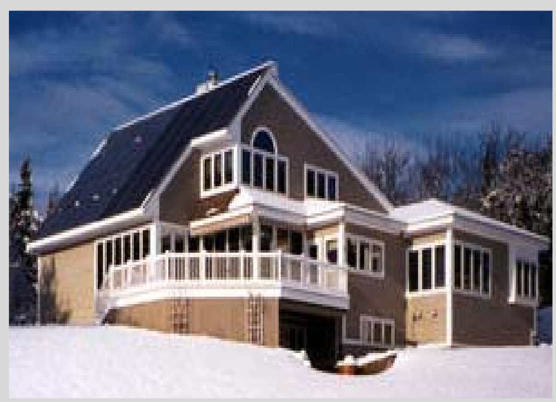
Structural Factors

- *Building energy requirements* – The design of a BIPV system should take into account whether the building should be able to operate independent of the electrical grid, which requires batteries or other energy storage systems.
- *Solar system design* – The design of the PV system itself is determined by the buildings energy requirements, and any structural or aesthetic limitations that may limit material choices. Crystalline silicon panels have higher electricity outputs per m^2, but greater costs and design constraints. Thin-film materials generate less electricity per m^2, but are less expensive and may be integrated more easily onto more surfaces. Either (or both) may be appropriate, depending on the specific situation.



Installing a solar awning over the back porch of a single-family home in California. The system provides both electricity and shade for outdoor activities. (Left: Photo – AstroPower)

This house in Maine features a 4 kW PV system integrated with solar thermal collectors to provide hot water as well as space heating through a radiant floor system. The house also incorporates passive solar and advanced insulation measures. A net metering arrangement with the local utility eliminates the need for on-site storage. (Right: Photo – William Lord)



About the Solar Energy Industries Association

Established in 1974, the Solar Energy Industries Association is the national trade association of the U.S. solar energy industry. As the voice of the industry, SEIA works with its 1,000 member companies to make solar a mainstream and significant energy source by expanding markets, removing market barriers, strengthening the industry and educating the public on the benefits of solar energy.

For a referenced version of this factsheet and more information, please visit www.seia.org.